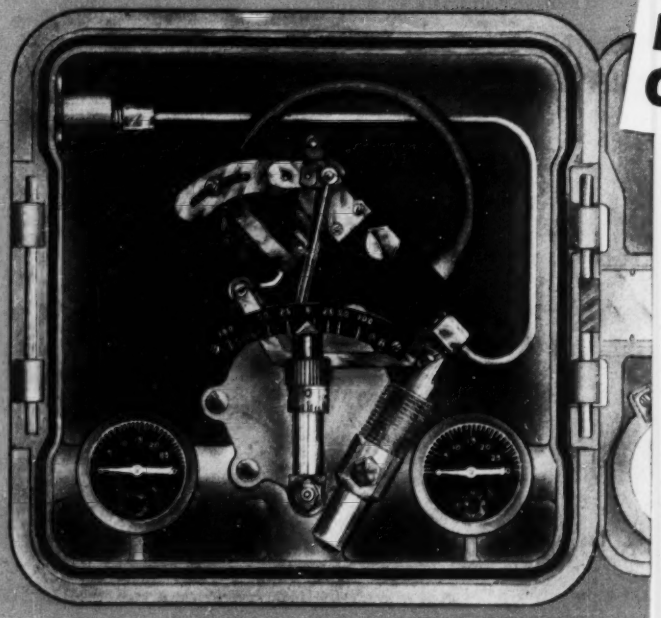
Instruments and AUTOMATION

Looking For The Finest Instrument-Type Pressure Control Pilot On The Market?



It's The New BS&B CLIMAX Type 1440!

OPERATIONAL FEATURES

Straight Line Proportional Action!

- √ Factory Calibration of Bourdon Tube, Proportional Bellows, Feed Orifice Nozzle and Proportional Snap Action Band Scale.
- √ Spring Loaded Bellows with Built-in Overtravel Protection.
- √ Flow Tested Feed Orifice Nozzle with Graduated Micrometer Set Point Adjustment.

Improved Sensitivity And Faster Controller Response Through The Power Relay Mechanism

- √ Double Diaphragm, Pressure Balanced.
- √ Molded Diaphragms.
- √ High Capacity Pilot Valve.
- √ Intermittent Bleed.

CONSTRUCTION FEATURES

- √ Weatherproof Case of Die Cast Aluminum Designed for Universal Mounting.
- √ Compact Size — 8" x 8" x 4".
- √ Two-Way Door Hinges to Left or Right, as Convenient.
- √ Straight Line Piping.
- √ Push Button Feed Orifice Cleaner.
- √ Pilot Action Reversible by Moving a Single Link, Without Tools.
- √ Snap Action or Proportional Band Settings Can be Made Without Tools.
- √ No Loose Linkages, Resulting in Easier Adjustment and Greater Sensitivity.
- √ Easy Parts Replacement or Assembly.

Here's that new and better Instrument-Type Pressure Controller you've been waiting for—the BS&B CLIMAX Type 1440! Designed to handle both positive and negative pressures from high vacuum to any amount of pressure desired up to 10,000 lbs., Type 1440 is an instrument of highest sensitivity and utmost accuracy.

Bourdon Tube actuated—with all tubes, bellows assemblies, feed orifices and bleed nozzles calibrated—this unit has an output of 2.5 standard cubic feet per minute with a 17 lb. supply pressure. It will stroke a valve with 135 sq. in. diaphragm and 1½" of travel in 10.8 seconds for a pressure change of 3-15 lbs. on a supply pressure of only 17 lbs.!

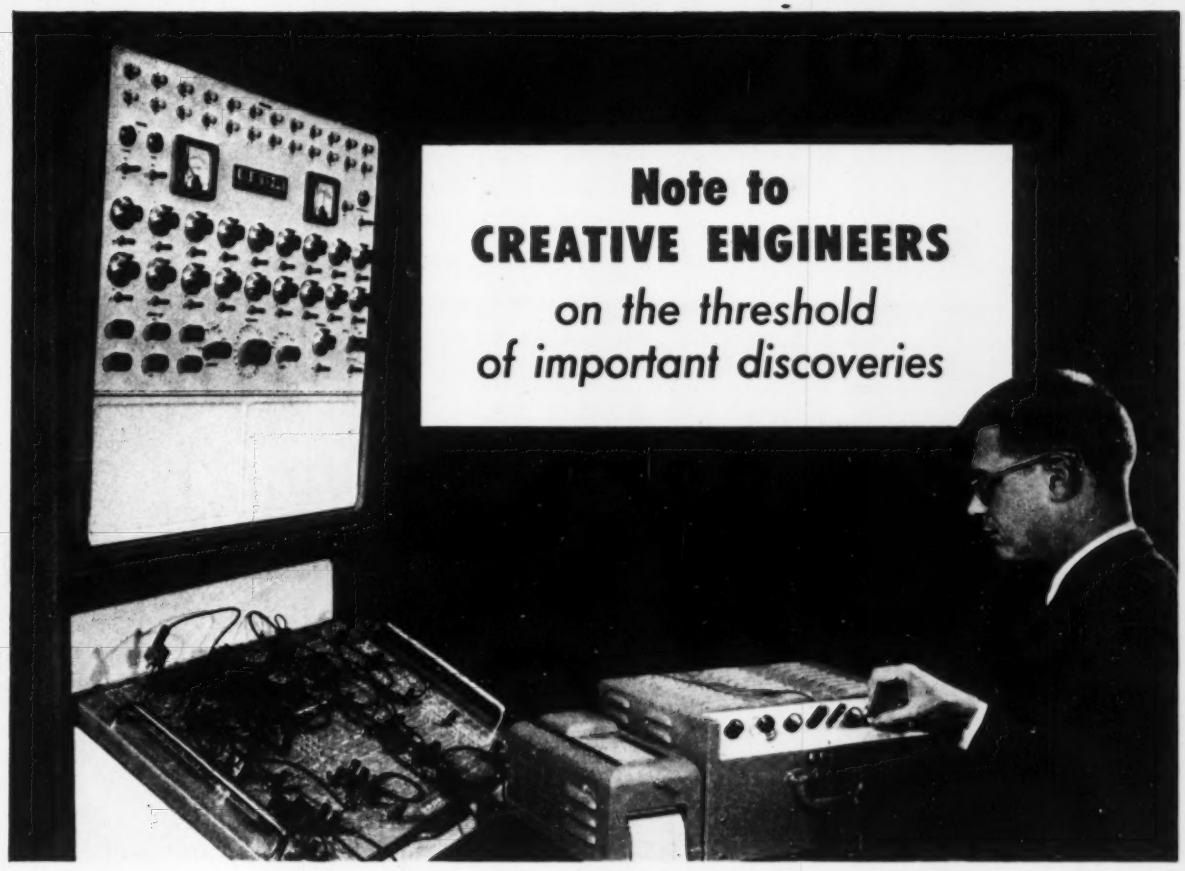
Adaptable to vacuum relief control, reduced pressure control, fluid pressure control, pump discharge pressure control, boiler steam pressure control, off-and-on control, or snap action where each of the two limits may be set at desired points within 10% to 75% of the Bourdon Tube range. Bourdon Tube assemblies are available in bronze with ratings from 15 to 600 lbs., and in 4130 steel, 410 stainless steel or 316 stainless steel with ratings from 15 to 10,000 lbs. It's the only Pilot we know of that can be top valve mounted, yoke or spring case mounted, instrument board mounted or wall mounted.

For complete information, contact your BS&B Representative . . . or write to . . .

BLACK, SIVALLS & BRYSON, INC.
Climax Controls Division, Dept 4-V7
7500 East 12th Street — Kansas City 26, Missouri

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY

For more information circle 1 on inquiry card.



Note to CREATIVE ENGINEERS

on the threshold of important discoveries

GEDA is an engineering tool which has already proved itself to be a responsible factor in many recent engineering advancements – *advancements which never would have been made otherwise because their discovery would have been either (1) too time-consuming, or (2) impossible to make without it!*

Pioneered and built by Goodyear Aircraft Corporation, major producer of electronic differential analyzers—this analog-computing equipment offers unique versatility, flexibility and scope.

Primary reasons for the success of GEDA are that it is very simple to program, *easy to use*—requires no learning of specialized mathematics, produces the results of a problem in graphic recordings of voltages and wave forms—forms which are already familiar to the engineer.

As a result, engineers working with GEDA have found they can do a job *better*, do it *faster*, do it *confidently*. Time after time, GEDA has rewarded these men with results which have more than justified their faith—opened up new avenues of approach to the design of complicated equipment through the solving of an initial problem where analytic solutions hitherto had seemed impossible.

WRITE FOR NEW CATALOG. *Free 52-Page Booklet describes complete line of GEDA equipment – the L3-linear analog computer, the N3-nonlinear analog computer, the R5-six-channel recorder, the R3-two-channel recorder amplifier, the T1-curve follower, the M1-impedance bridge. Write: Goodyear Aircraft Corporation, Dept. 931ES, Akron 15, Ohio.*

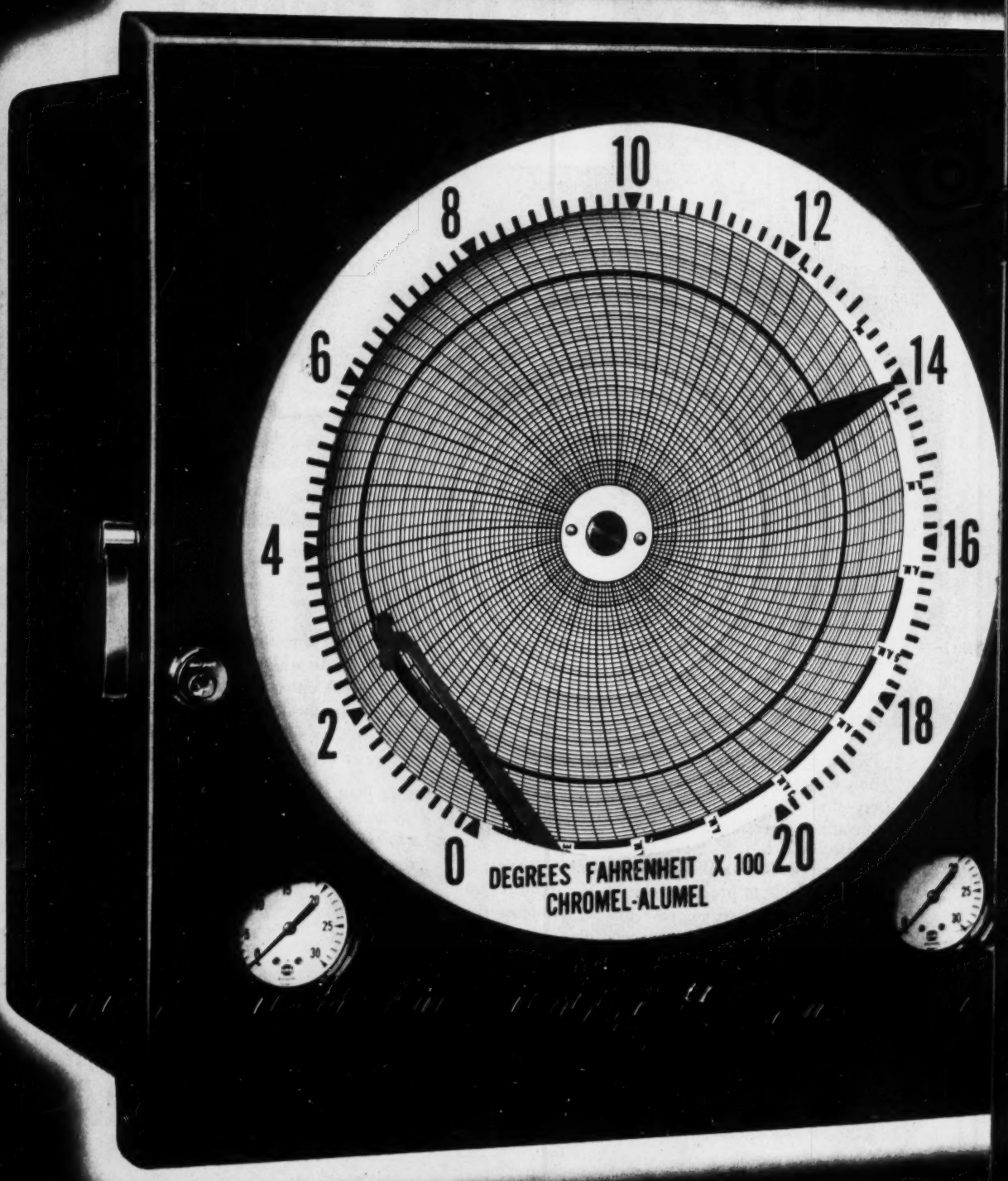
***Give Your Hunch A Chance*—with GEDA built only by**

GOODYEAR AIRCRAFT

GEDA–T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

For more information circle **2** on inquiry card.

General Electric Announces

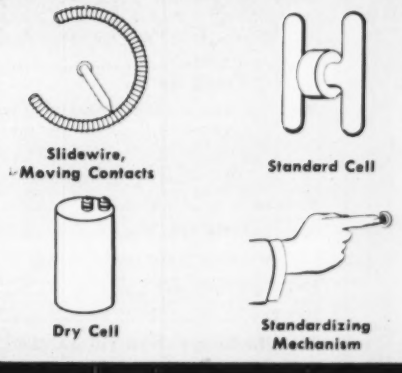


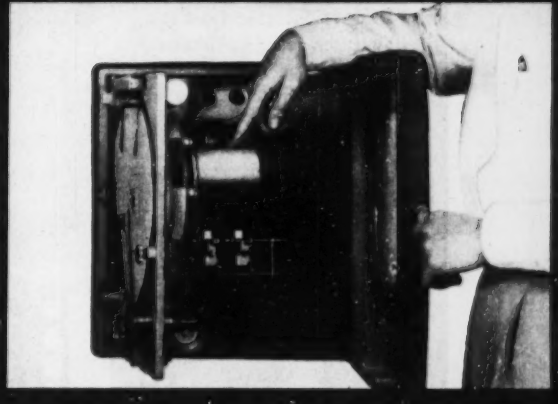
A New Recording Controller

REVOLUTIONARY MEASUREMENT-CIRCUIT DESIGN ELIMINATES MANY TROUBLESOME COMPONENTS

General Electric's new d-c recording controller assures you of having less maintenance by eliminating conventionally used dry cells, standard cells, slidewire and sliding contacts. Replacement costs for dry cells, or worn, corroded electrical contacts are gone, and your savings increase with the exacting control of this new instrument.

THE MAGNETIC STANDARD provides truly continuous standardization in new G-E recording controller and the measuring circuit incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control can never be experienced, during standardization periods, with the constantly balancing G-E system. Your end-product quality, under the effects of increased accuracy and precision of measurement, will reflect even more cost and time savings in your operation.





By eliminating the above components, the new G-E potentiometric recording system reduces maintenance time (at no extra cost) and excludes such time-consuming jobs as replacing dry cells, or cleaning moving contacts.

Condensed size through unit construction makes the new Magnetic Standard easy to service. The controller has a maximum number of plug-in parts to facilitate range changing in the field. No unsoldering is required.

See this and other G-E instruments at the Instrument Society of America Show, September 15-21, Commercial Museum, Philadelphia, booths 531-537.

SECTION C 602-276
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Please send me a free copy of the new bulletin, GED-2100, which features the New Recording Controller in a colorful, twenty-page picture story.

Name ..... **Company** .....
Street ..... **City** ..... **State** .....

GENERAL ELECTRIC

For more information circle **3** on inquiry card.

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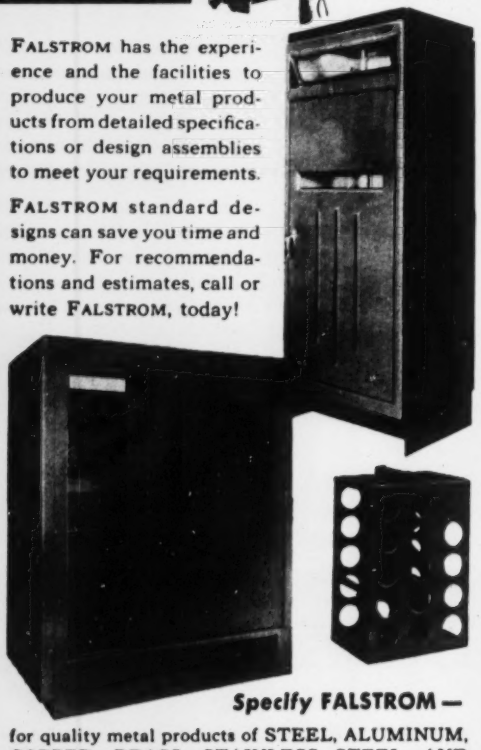

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QUALITY METAL PRODUCTS FOR INDUSTRY SINCE 1870

For more information circle 4 on inquiry card.

Instruments and AUTOMATION

Vol. 27 July, 1954 No. 7

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JOURNAL of the SOUTHERN CALIFORNIA METER ASSOCIATION

Valve Positioners 1090
by Maynard Strader

COVER STORY

The cover illustration is a picture of a high-pressure gas-metering installation at the Paloma Cycling Plant, in a unitized condensate field operated by the Western Gulf Oil Company, near Bakersfield, California. The panelboard is built directly over the orifice plates of the meter runs. In addition to making a neat installation, this insures perfect drainage of condensate as there are no traps in the meter bodies. In this installation, 25 Barton "rupture-proof dual-bellows type" meters are recording flows in both the production and injection of natural gas at operating pressures from 1500 to 5000 psi.

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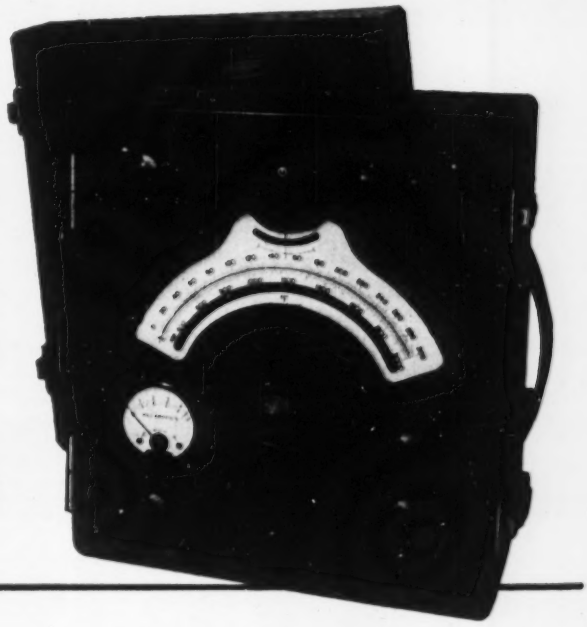
LEWIS PORTABLE PYROMETER POTENTIOMETERS

FOR MEASURING TEMPERATURES ELECTRICALLY

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY



ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide, and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

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NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle 5 on inquiry card.

must a well engineered chart recorder be expensive?

fielden says, "no!" when you can install a MULTIPOINT Recorder with up to 48 or 96 separate points—with each point available at a cost unheard of before!

Reason: Simplified design, circuitry, and construction. The chart mechanism is rugged, but so simple in form that there is little or no maintenance throughout the life of the instrument. Yet it's *accurate*—to ±½% of full scale, with a sensitivity of 0.1% and reproducibility of ±0.5%. Fielden furnishes 3 types of Multipoint Recorders: TEKTOLOG electrical quantity for pH, thermocouple and tachometry; A.C. NULL BALANCER for resistance temperature and conductivity measurements; and D.C. NULL BALANCER.

Does simplified, low cost—and reliable instrumentation appeal to you? Then use the coupon below today for full details.

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CONTROLS COMPANY

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For more information circle **6** on inquiry card.

Instruments and AUTOMATION

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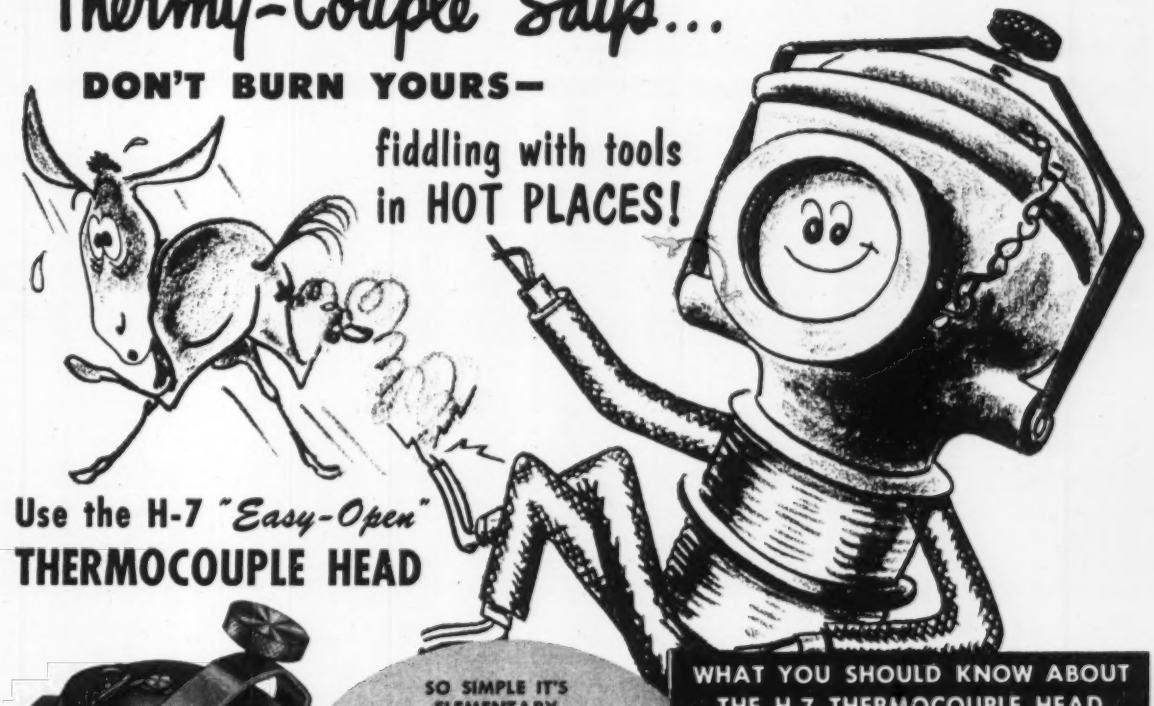
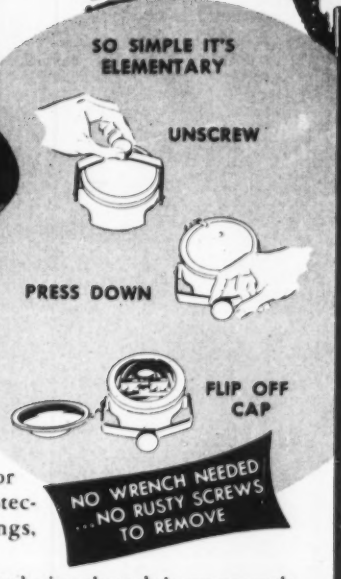
"Thermy-Couple" Says...

DON'T BURN YOURS—

fiddling with tools in HOT PLACES!



Use the H-7 "Easy-Open" THERMOCOUPLE HEAD



The H-7 is an all-purpose thermocouple head that will accommodate *any size* wire whether base metal or platinum. It fits all standard protection tubes with threaded fittings, metal or porcelain.

Available in 1", ¾" or ½" standard pipe thread thermocouple openings. ¾" conduit lead wire opening.

SEE AUGUST ISSUE FOR SPECIAL ANNOUNCEMENT CONCERNING OUR BIG ENTERTAINMENT DURING ISA CONVENTION.

WHAT YOU SHOULD KNOW ABOUT THE H-7 THERMOCOUPLE HEAD

- It is moisture-proof, rust-proof and non-corrosive.
- Gas tight and heat resistant.
- Light weight and compact.
- One-piece Thermocouple assembly *snaps out, snaps in.*
- Stainless steel cover—Cast aluminum base.
- Asbestos gasket (stays in place).
- Cover chained to base.
- Polarity marks plainly marked.
- Millions Now in use.
- This Super Head is lower in price than ordinary Heads.
- Immediate delivery, any quantity.
- Molded transite connector block.

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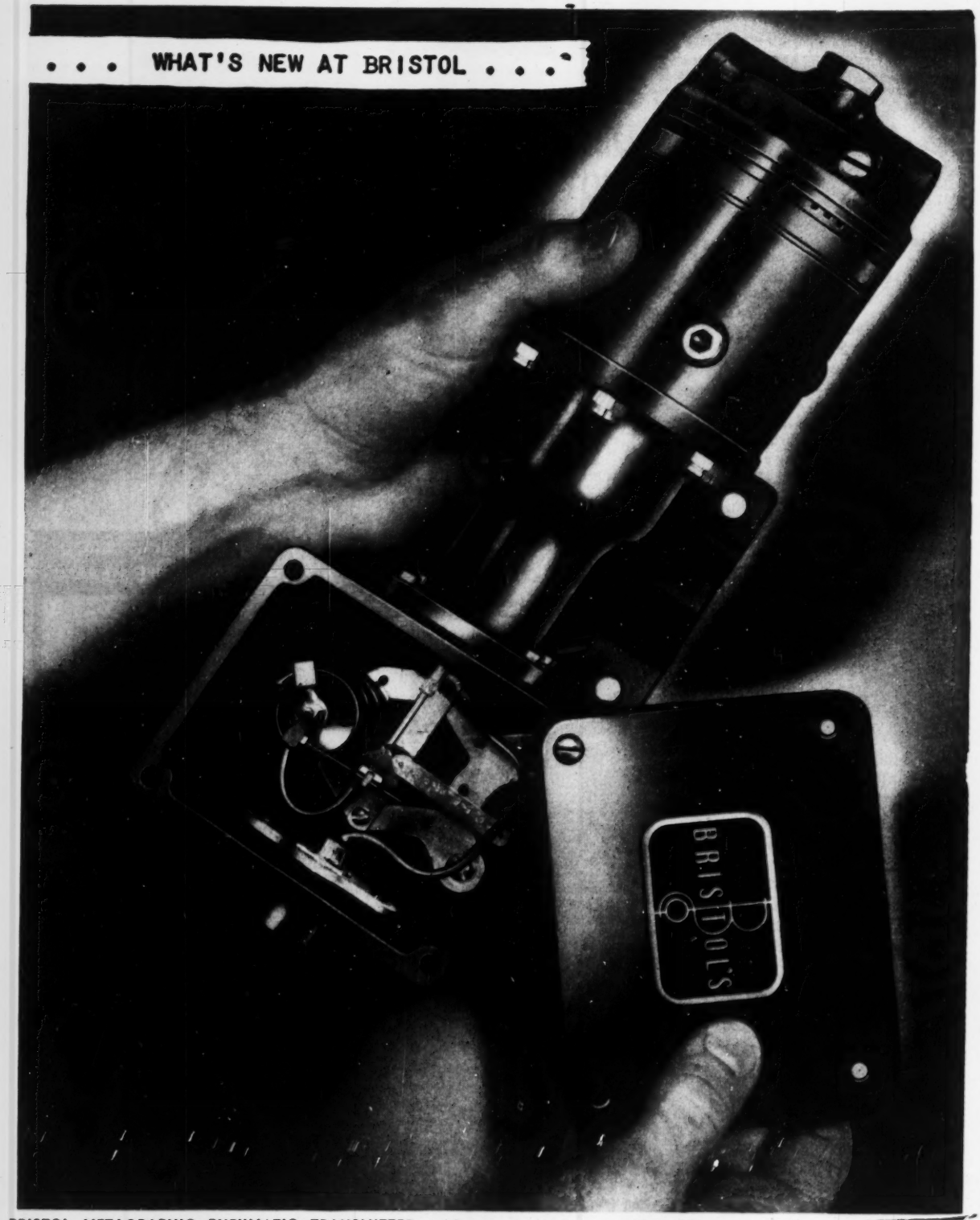


BRISTOL METAGRAPHIC PNEUMATIC TRANSMITTER, with cover removed. The frictionless transmitter, with only one pivot and no flexures, will operate in any position, indoors or out. The unit is sensitive to extremely small changes in the measured quantity, as minute as 0.03% of range, including reversal. You can get the Metagraphic transmitter in a wide selection of ranges: Pressure (0 to 5" water to 0-10,000 psi), vacuum (0 to 5" water to full vacuum), temperature (−100° F to 1000° F), liquid level (0 to 5" water and up), flow (mercury manometer, bell type, and Barton meter bodies), and differential pressure (0 to 2.0" water to 0.500" water). Suppressed ranges are available. Over-range protection is standard with the Metagraphic transmitter, up to 500% for some ranges.

For more information circle **7** on inquiry card.

Simplicity?

LOOK INSIDE!

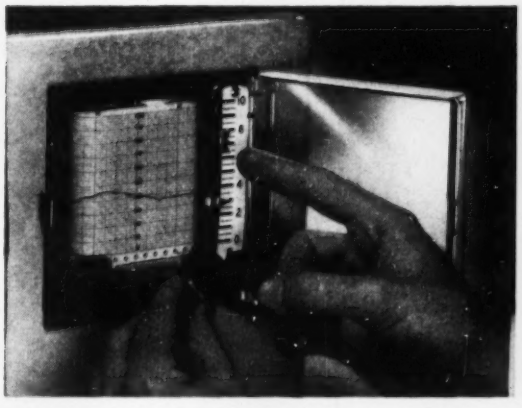
• When you remove the cover from one of Bristol's Metagraphic pneumatic transmitters, you're quickly aware of the inherent simplicity of Bristol's world-famous measuring element. This unit, the result of years of measuring element research and development, has operated in Bristol instruments that have chalked up as much as 35 years continuous service without attention.

Here are some of the features of the Metagraphic transmitter, designed to give you new standards of accuracy and reliability in measuring and transmitting readings of temperature, pressure, vacuum, differential pressure and liquid level.

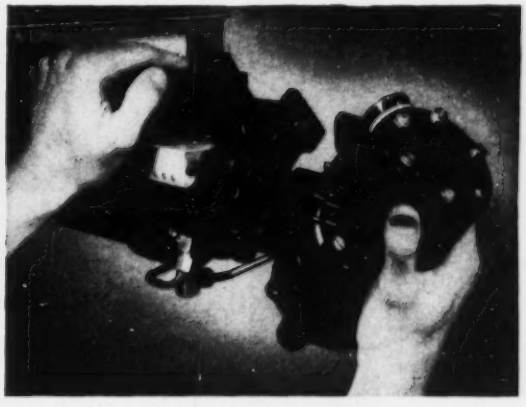
- **NON-BLEED BOOSTER PILOT** for low air consumption. In the balanced position, air consumption is only 0.07 scfm.
- **HIGH-SPEED TRANSMISSION** and superior control result from large air capacity of the pneumatic relay — 3.0 scfm.
- **INDICATING DIAL GAUGE,** to show output pressure, can be screwed into front of transmitter. No piping or fittings are needed.
- **WEIGHS ONLY 7½ POUNDS,** is weatherproof and can be installed in any location and operate in any position.

Get the whole story on the Metagraphic transmitters. Write for free bulletin A105, to The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut.

Meet the rest of the Metagraphic family . . .



BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned a reputation as the "biggest little instrument in the industry". The continuous valve-position indication, separate from set-point indication, gives continuous data on control valve position and process level.



THE BRISTOL CONTROLLER can be plugged into back of receiver, placed at process. Available in on-off, proportional, proportional plus reset, proportional plus derivative, and proportional plus reset plus derivative. Experienced instrument men will recognize this as a unit* service-proved in thousands of installations.
*Licensed under C. B. Moore patents

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

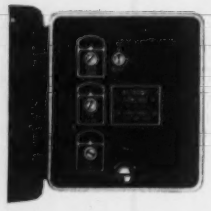
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **7** on inquiry card.

AUTRONIC TEMPERATURE TRANSMITTERS— Two types available: (1) T2C thermocouple converter for use with thermocouples. Bulletin A-712. (2) T2E resistance thermometer with T2A thermometer adapter including interchangeable range card. Bulletin A-706.

AUTRONIC PRESSURE TRANSMITTER — P2T pressure primary element for up to 5000 psi eliminates transmission lags. No friction, extremely low hysteresis. All-electric signal transmission. Bulletin A-708.

AUTRONIC ADAPTER UNITS — Swartwout makes several adapter units to utilize any a-c or d-c signal, such as strain gauges, pH, oxygen, etc., for use with the controller, recorder, or other Autronic components.



AUTRONIC CONTROLLER — Heart of the Autronic System. Instantaneous, all-electronic response. Proportional, automatic reset, and/or rate action adjustment ranges; with or without set-point. Bulletin A-702.

Swartwout

AUTRONIC COMPONENTS

are the answer when rapid, precise control is the problem

Temperature . . . pressure . . . flow . . . pH . . . variable speed and many other control requirements. If it can be done by electro-mechanical or pneumatic means, it can be performed better, faster, easier, and generally at lower cost with Swartwout Autronic systems or components. Some are illustrated below. So if control and/or recording is your problem, call your Swartwout representative for a consultation at your convenience.

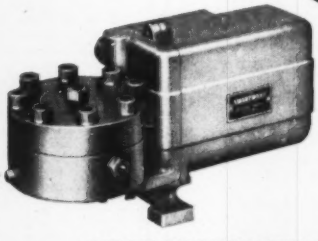
A-9851

AUTRONIC FINAL ELEMENTS — P2R power relay (above), an electro-pneumatic transducer, takes d-c control signal and converts it to proportional air loading pressure. Bulletin A-710A. Other electrical final elements supplied for variable speed motor control, magnetic amplifier, etc.

AUTRONIC INDICATOR — Rapid, accurate, miniature plug-in type instrument interchangeable with recorder. Supplied with or without set-point adjustment.

AUTRONIC RECORDER — Miniature plug-in type null-balance instrument gives true linear trace on 31-day strip chart. With or without set-point adjustment. Bulletin A-704.

AUTRONIC MANUAL CONTROL — Operates independently of recorder and controller. Continuous indication of valve position. Simplified switchover means bumpless transfer. Bulletin A-705.



AUTRONIC DIFFERENTIAL PRESSURE TRANSMITTER — D2T transmitter with unique diaphragm pressure seal that eliminates bellows and torque tubes for extreme sensitivity at static pressures as high as 5000 psi. All-electric, no vacuum tubes. Bulletin A-707A.

Swartwout *Autronic* **CONTROL SYSTEM**

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **8** on inquiry card.

Trends...

Instruments and AUTOMATION

Patent problem is developing in atomic-energy field as nuclear power generation becomes economic. Present atomic energy act (passed in 1946) retains title to all fissionable material in hands of AEC (Section 1804) and provides that no patent shall be granted for any invention or discovery (Section 1811). Patent problem must be resolved before large private investment will be forthcoming; yet government has $11-billion investment to protect.

Expansion programs based on trends (rather than on short-term business forecasts) is new concept for management. Economy as a whole is growing 3.5% per year (equivalent to 41% in ten years). Some segments of economy grow at even faster rate; for example, 10% increase in general business causes 15% increase in electrical machinery. Research and replacement expenditures by industry cause disproportionate increase in Instrumentation.

End-product production of electronics will reach $6.7 to $7.6 billion by 1960, forecasts F. W. Mansfield of Sylvania Electric Products at recent meeting of West Coast Electronics Manufacturers' Association. The 1953 volume was $4.59 billion (this includes government purchases of $2.8 billion).

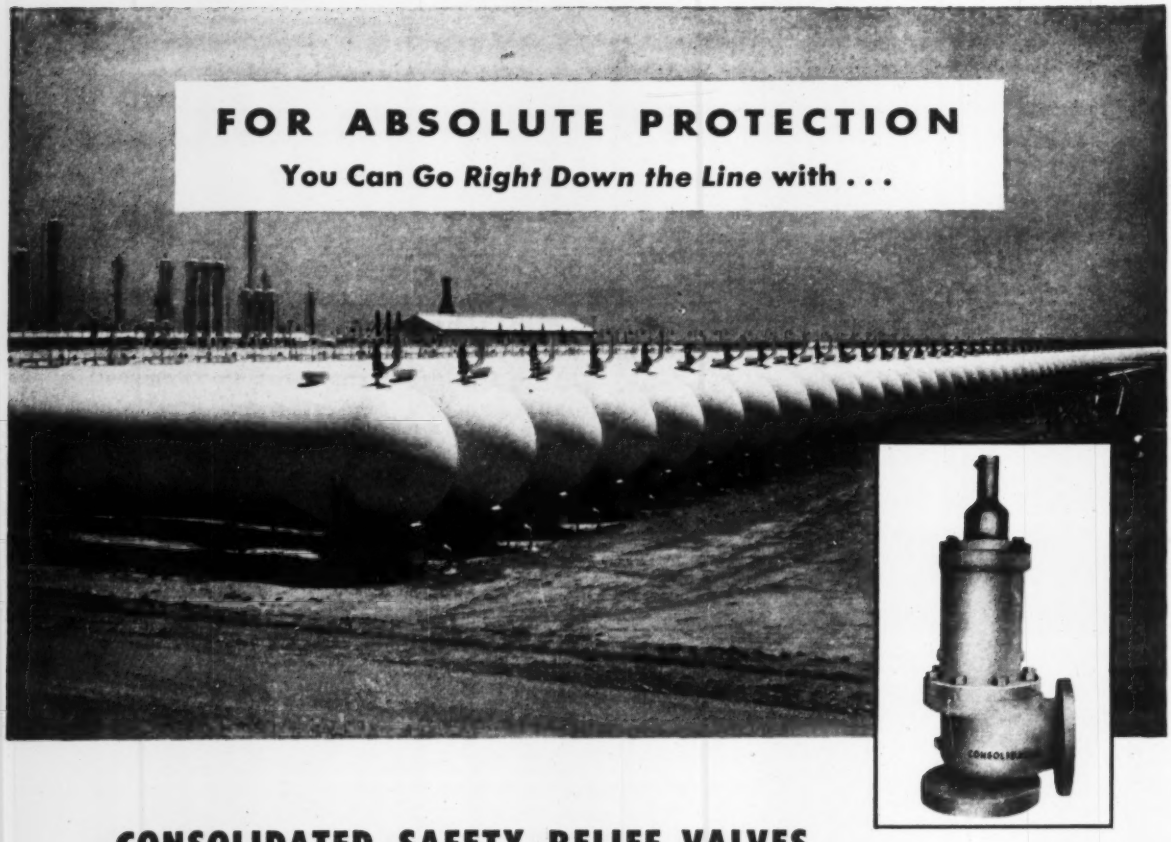
Growing importance of instrument manufacturer is brought out in recent article "The Art of Engineering a Power Station," (Instruments & Automation, June, 1954). Roger Marion, consultant, points out that savings were realized from single-contractor supervision, and that contract for entire control equipment, control room, and control equipment not in control room was awarded to instrument company (Leeds & Northrup) in competitive bidding against electrical manufacturer.

Growing importance of Instrument Department is recognized by Union Carbide and Carbon Corporation; Head of Instrument Department (Ralph Webb) is at same level with other company Division Heads.

Watch for rebirth of the differential equation (now quickly forgotten by engineers other than theoretical design engineers). The analog is giving new meaning to the differential equation, making it possible to solve operation problems via simulation, and making it necessary for all engineers to brush up on math.

First commercial production of silicon transistors is announced by Texas Instruments, Inc. All previous production units used germanium. Silicon possesses superior temperature stability.

Laboratory for powder metallurgy is planned by Baldwin-Lima-Hamilton . . . New $2 million lab opened by Raytheon Mfg. Co. at Bedford, Mass. . . . Research Corporation, New York, establishes West German research program . . . Hercules Powder Co. opens new agricultural chemical research lab . . . Bendix Aviation Corp. announces new research program on non-military applications of atomic power . . . Eaton Mfg. Co., Cleveland, will build new research center.



CONSOLIDATED SAFETY RELIEF VALVES

COMPLETE PROTECTION for personnel, property and equipment rates top priority in safety engineering wherever industry must confine gases, vapors and liquids in unfired pressure vessels. That is why Consolidated Safety Relief Valves are such a common sight on processing facilities, pipelines, pumps and storage tanks.

Consolidated Safety Relief Valves incorporate design and construction features that assure *dependable tightness* under the severest discharge piping stresses. Unfired pressure vessels are absolutely safeguarded against overpressures. No matter how tough the conditions of use, you can be sure of continuously reliable performance at the rated capacity.

SIMPLE DESIGN — 25% fewer parts than ordinary safety valves — means that Consolidated Safety Relief Valves minimize maintenance and standardization problems and save in long-life operation.

Write for complete information.

CONSOLIDATED SAFETY RELIEF VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

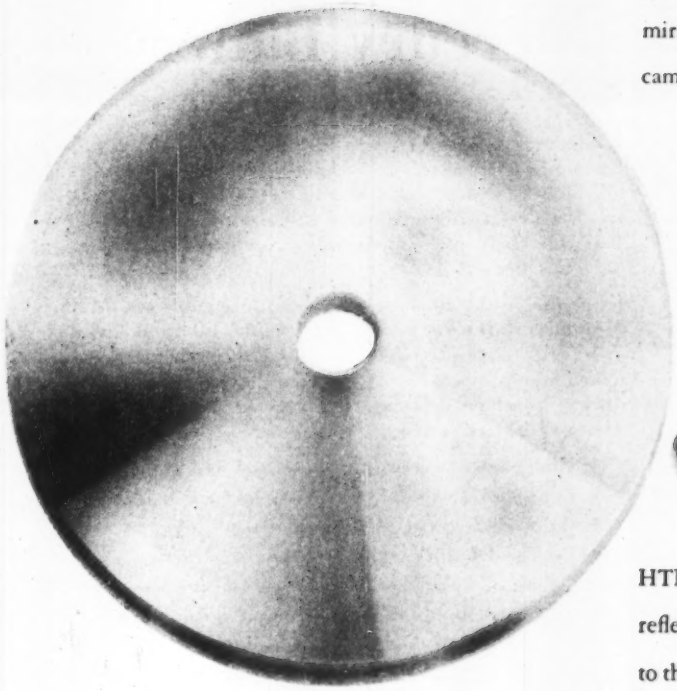
MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

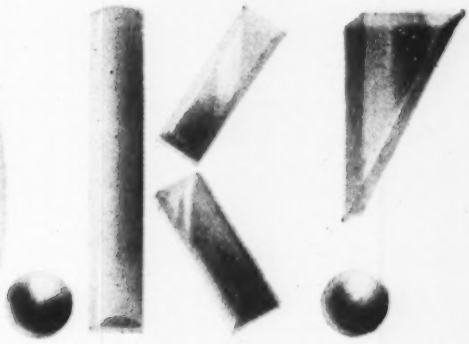
For more information circle 9 on inquiry card.

Houston Technical Laboratories is a dependable source for optical components. HTL maintains an exacting quality of workmanship. Further . . . prices are competitive and deliveries are prompt.

HTL optical components custom-made for every need!

HTL skilled craftsmen are experienced with cylindrical, spherical and complex lenses as well as flat, cylindrical or spherical mirrors for any optical system. Range of sizes includes galvanometer mirrors of .0025 inch thickness to 14 inch camera lenses.





HTL exclusive aluminum alloy coating has reflectivity in all ranges of the spectrum equivalent to that of aluminum. It is highly resistant to abrasion and corrosion. HTL is also equipped to apply standard or unusual mirror coatings and low reflectance lens coatings as specified by our customers.

Write for descriptive literature.

HTL

HOUSTON TECHNICAL LABORATORIES

A SUBSIDIARY OF TEXAS INSTRUMENTS INCORPORATED

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For more information circle 10 on inquiry card.

Dependable MALLORY Mercury Batteries

P.R. MALLORY & CO. Inc.

Power Specialized Electronic Instruments

Mallory Mercury Batteries are used to supply power for transmitting data from balloon-borne equipment 20 icy miles in the stratosphere, and to record what goes on at the tip of a drill two superheated miles down an oil well. And they do their job dependably . . . where other types of batteries have failed.

Even under the most severe climatic conditions, Mallory Mercury Batteries give long, stable life and excellent operating characteristics. Particularly advantageous in instrument applications is the way they resist deterioration during extended storage periods. In addition, Mallory Mercury Batteries offer these features:

- **High ratio of energy to volume and weight**
- **Constant voltage and current—ideal for transistor circuits**
- **No need for recuperation periods**
- **Leak-proof, dimensionally stable construction**
- **Operation over wide temperature and pressure ranges**
- **Resistance to humidity and corrosive conditions**
- **Highly resistant to impact and acceleration**

Our new Technical Bulletin 1-8 gives complete data on single cells and multi-cell stacks and packs. Write for your copy today.

P.R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO. Inc., BATTERY DIV., NORTH TARRYTOWN, N.Y.

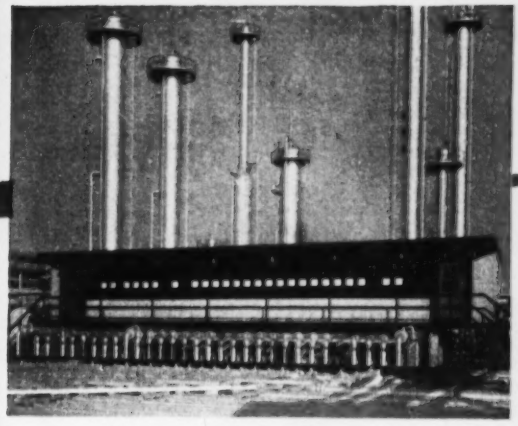
For more information circle **11** on inquiry card.

BARTONS *on the line...*

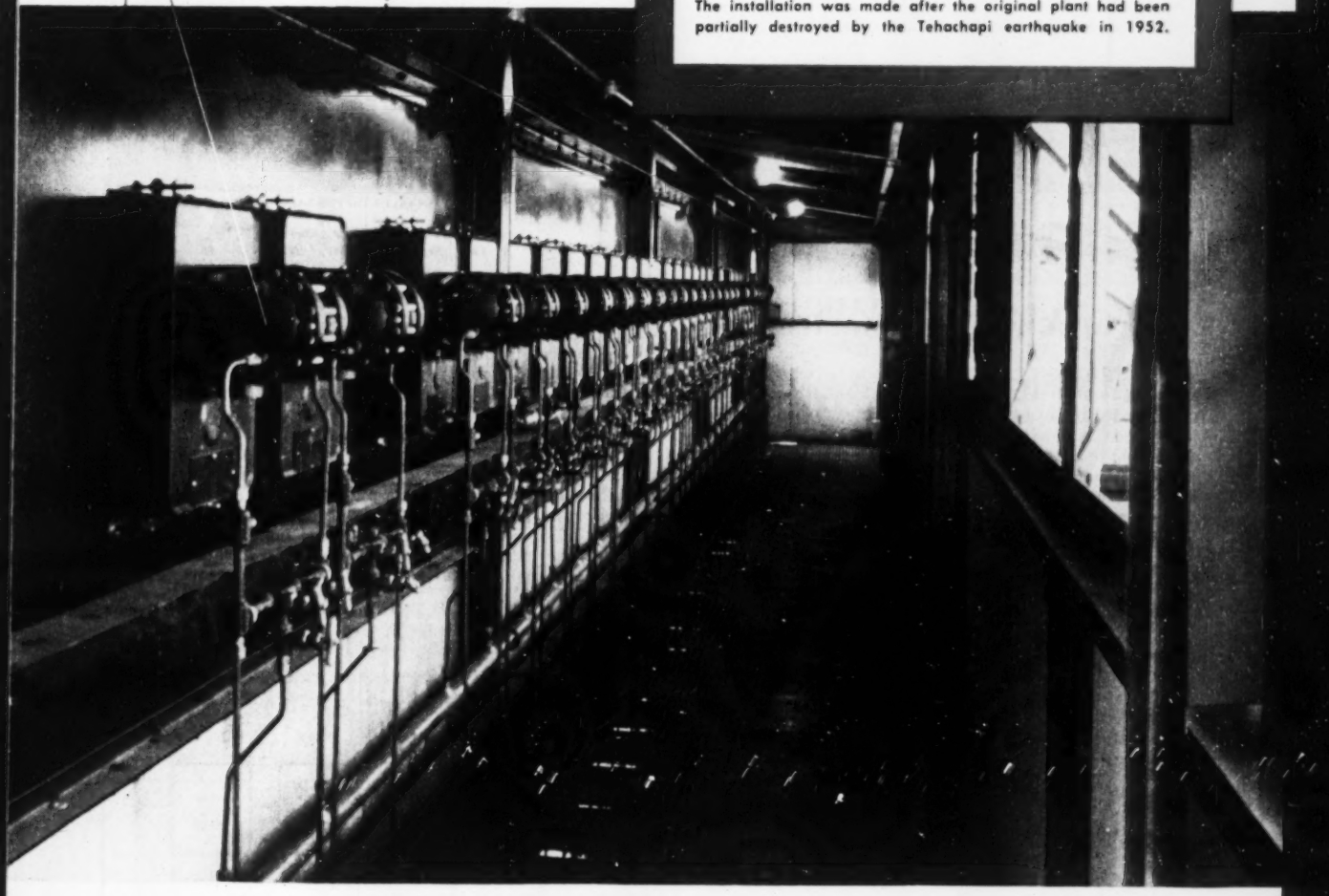
in one of the *TOUGHEST* services!

reliable performance	simplest installation
low cost maintenance	accurate measurement

For information on your special problems contact our sales engineers in principal cities throughout the United States.



COVER STORY: The cover is a picture of a high pressure GAS metering installation at the Paloma Cycling Plant, in a unitized condensate field operated by the Western Gulf Oil Company, near Bakersfield, California. The panelboard is built directly over the orifice plates of the meter runs. In addition to making a neat installation, this insures perfect drainage of condensate as there are no traps in the meter bodies. In this installation, these 25 Barton "rupture-proof dual bellows type" meters are recording flows in both the production and injection of natural gas at operating pressures, from 1500 to 5000 psi. The installation was made after the original plant had been partially destroyed by the Tehachapi earthquake in 1952.



Back view of Barton flowmeters as installed at Paloma Cycling Plant

BARTON

INSTRUMENT CORPORATION

INDUSTRIAL INSTRUMENTS

1429 SOUTH EASTERN AVENUE LOS ANGELES 22, CALIFORNIA

For more information circle 12 on inquiry card.

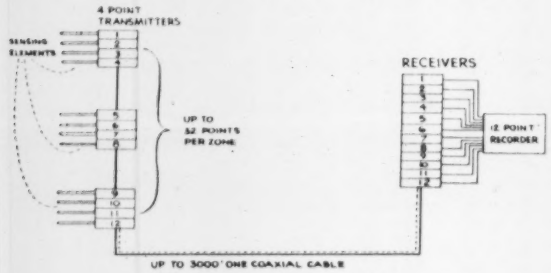
INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Electronic Scanner

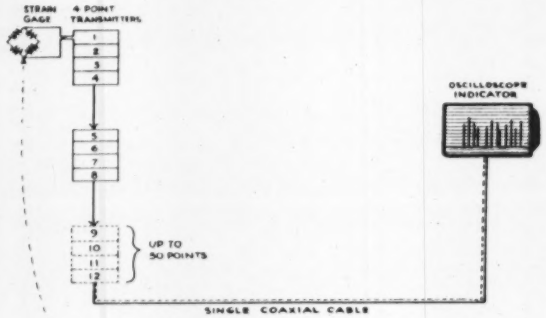
NEW YORK, N. Y.—Electronic techniques, revealed in new Kybernetes scanner, make possible new order of response speed and versatility for multipoint monitoring systems. Each point to be monitored has magnetic-amplifier-type transmitter, which produces a signal with duration of 250 microseconds and amplitude proportional to monitored variable.

Each "chain" of transmitters (up to 32 points) is triggered sequentially 60 times per second, producing 1920 signals per second. All signals can be displayed on oscilloscope, can be recorded photographically, or on potentiometer.



BLOCK DIAGRAM ILLUSTRATING 12 POINT RECORDING SYSTEM

Number of 32-point zones can be increased indefinitely, with upper limit established by resolution desired. Viewing tube can be standard TV kinescope type. Alarms can be incorporated to warn of deviations beyond desired limits; simultaneous presentation of multipoint signals yields pressure or temperature patterns; high-frequency transient signals can be observed or recorded, any number of points can be built up by simple plug-in arrangement.



BLOCK DIAGRAM ILLUSTRATING VISUAL PRESENTATION OF PROCESS VARIABLES ON THE FACE OF AN OSCILLOSCOPE TUBE

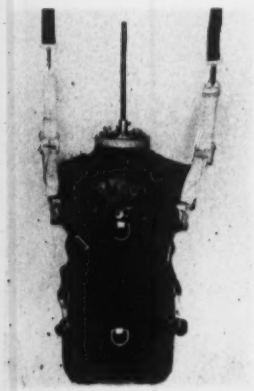
* NOTE: A STRAIN GAGE SHOULD BE SHOWN FOR EACH TRANSMITTER POINT, 1 - 12.

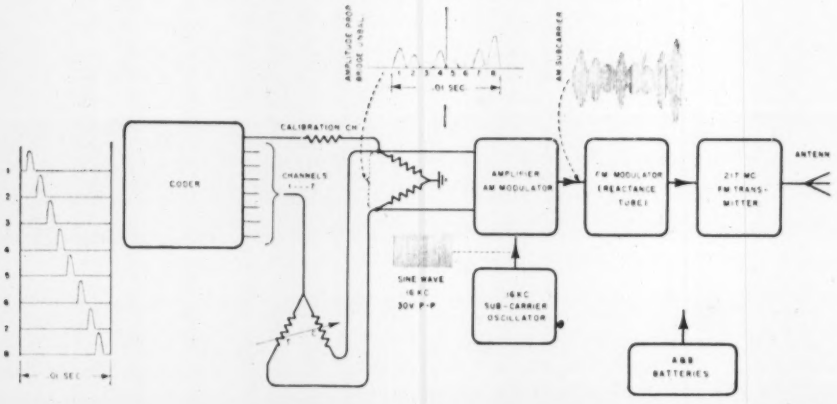
Parachute Telemetering

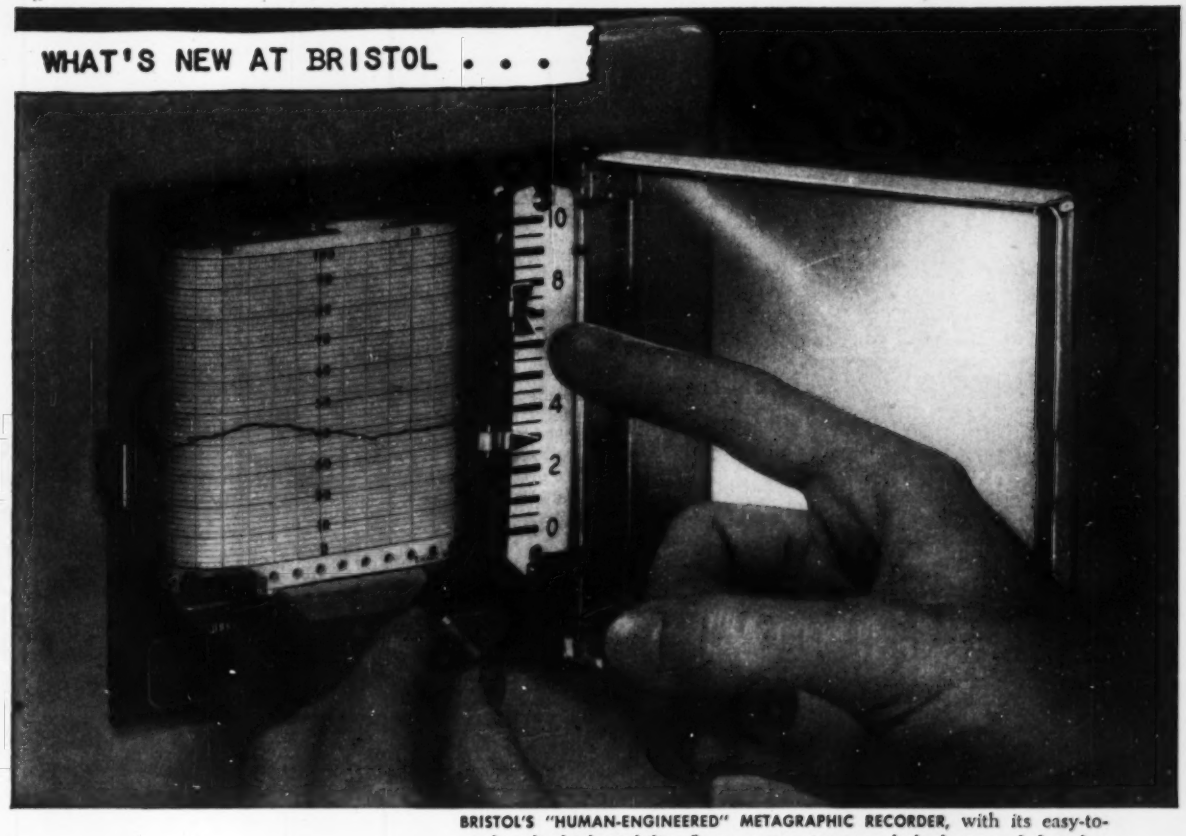
WASHINGTON, D. C.—A parachute telemetering system has been developed by the National Bureau of Standards for testing experimental parachutes for use with modern high-speed aircraft. Electronic equipment mounted inside a parachute-borne torso-shaped dummy transmits information (altitude and forces at various points) in coded form to a ground station, where the information is decoded. The system was developed for the Navy Bureau of Aeronautics by M. L. Greenough, C. C. Gordon and associates of NBS.

Resistance strain gages are arranged to sense both altitude (pressure) and the tension in various harness straps. An inductive-commutator arrangement excites one strain gage at a time, the output of the gages being combined to modulate a small battery-powered radio transmitter. Seven measurement channels and a calibration channel are provided. At the ground station, a spot on the face of a cathode-ray tube moves up and down with the amplitude of the modulating signal. This spot is recorded on continuously moving photographic film. The film record is then transcribed, using a semi-automatic film reader, to obtain plots of altitude versus time, and harness tension versus time.

The airborne transmitter operates on 217 megacycles and has an output of about 0.75 watt and a range of about 2 to 10 miles. Seven tubes are required for the entire airborne unit. The battery pack, which provides 7.2 volts at 1.0 ampere and 190 volts at 80 milliamperes, yields about 1 hour of service.







BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned the distinction of being the "biggest little instrument in the business."

Instrument men call Bristol's METAGRAPHIC Recorder

"... the biggest little instrument"

Sounds contradictory, but it's true. Take a look at one of our new METAGRAPHICS mounted on a panel board alongside of other instruments. The Bristol unit stands out – seems bigger than the rest – although chances are it's actually smaller (5" x 5¼"). The answer is that the Bristol instruments have been "human-engineered", making them easy to read, and clearly visible at greater distances.

The air-operated METAGRAPHIC, which records pressure, temperature, vacuum, flow, differential pressure, and liquid level, offers these big advantages:

SIMPLICITY . . . fewer moving parts, fewer adjustments, and less service required. Range changes can be made in seconds. True plug-in service.

CONTINUOUS VALVE-POSITION INDICATION . . . on same instrument scale as set-point scale, gives continuous data on control valve position—makes "bumpless" transfer possible simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

CONTINUOUS OPERATION . . . complete unit can be retracted for inking pen, and for set-point and zero adjustment without disturbing record or control.

Get the whole story on the "human-engineered" METAGRAPHICS – how they can help you get more accurate measurements, faster and easier. Write us today. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

6.4.4R

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **13** on inquiry card.

CUSTOM BUILT

Electrical Enclosures

BY

KIRK AND BLUM

Contract Manufacturing Facilities for

- Control Desks
- Boiler, Turbine and Generator Control Panels
- Power Distribution and Control Panels
- Switch Gear Housings
- Instrument Panels
- Cubicles
- Electrical Enclosures
- Machine Bases
- Transformer Enclosures
- Weatherproof Housings
- Breechings
- Air Ducts
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- Casings
- Hoppers

Whether you need one unit or hundreds . . . a simple transformer tank or a complicated control panel . . . Kirk & Blum has the men, experience and facilities to fabricate any electrical or related enclosure quickly and economically.

Complete facilities for fabrication of sheet steel, plate, light structurals, stainless, aluminum, monel and other alloys.

For more detailed information, request new literature on fabrication facilities and experience.

Write to: The Kirk & Blum Mfg. Co., 3111 Forrer Street, Cincinnati 9, Ohio.

KIRK AND BLUM

METAL FABRICATION

For more information circle 14 on inquiry card.

ON THE MARCH—CONTINUED

Primary-element Response

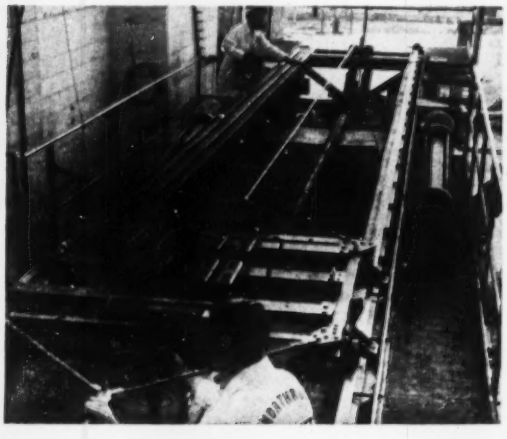
PITTSBURGH, PA.—A milestone in automatic control was disclosed here at the Semi-Annual Meeting of the American Society of Mechanical Engineers.

One of the obstacles to "perfect" automatic control of temperature is the "slowness" of primary measuring elements such as bulbs, thermocouples, etc. Yet exact knowledge of the response curve of even one primary element is difficult to obtain—and it usually pertains only to the conditions of a single test. That is why exact response-curve data have not been included in temperature-controller catalogs.

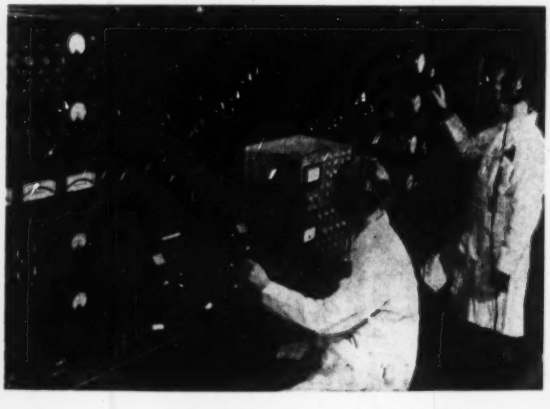
An auspicious start has been made by two instrument companies (Industrial Div. of Minneapolis-Honeywell, and Taylor Instrument Companies) in building elaborate test set-ups including hot- and cold-water tanks with ingenious automatic cycling controls and rapid-recording instruments. It probably will take years for complete data to be obtained, but this start is a milestone in the history of Automation.

Acceleration Test Facility

HAWTHORNE, CALIF.—Northrop Aircraft of Hawthorne, Calif. uses this "giant sling shot" to provide acceleration loads up to 25 g's for testing of aircraft components. The 250-pound aluminum carriage in the foreground is



pulled along the 45 foot track at high speed by a pneumatically-driven steel cable. Components weighing as much as 1200 pounds can be tested at forces up to 8 g's. The carriage measures 54 by 56 inches. Also shown is the bat-

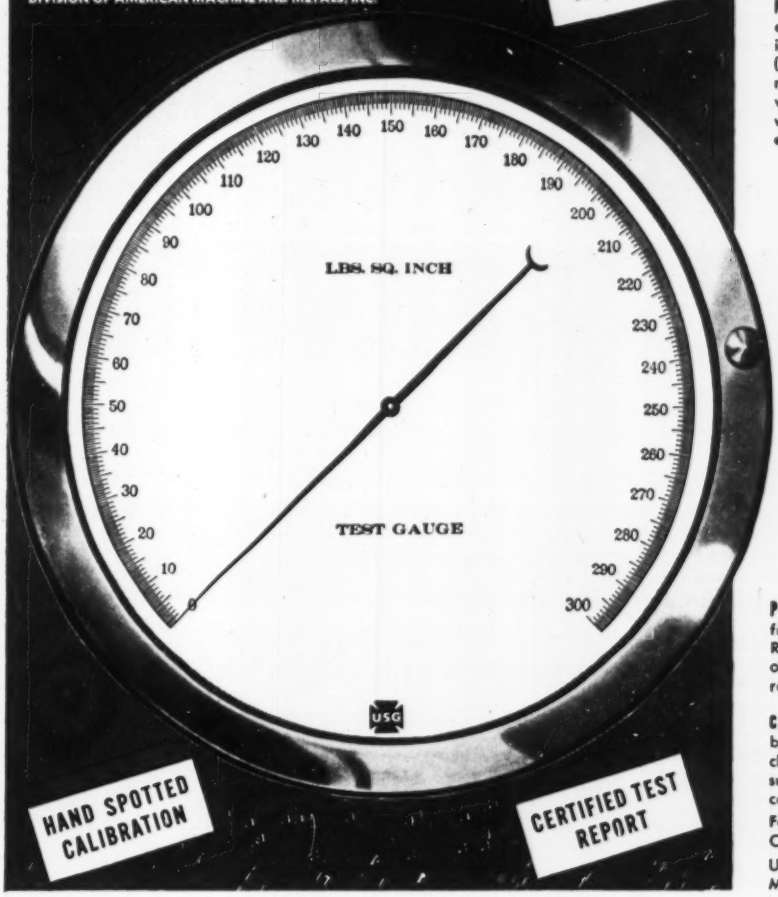


"300,000 LB. CAPACITY RIEHLE COMPRESSION TESTING MACHINE, MADE BY RIEHLE TESTING MACHINE DIVISION OF AMERICAN MACHINE AND METALS, INC."

For Peak Precision

USG LABORATORY TEST GAUGES

Wherever you require *peak precision* from a gauge—for compression or tensile strength testing machines, or for replacing or supplementing dead weight testers or manometers—you can use the accuracy of USG Laboratory Test gauges to advantage.



PEAK PRECISION—½ of 1% of the indicated reading above 20% of the maximum dial range and one part in 500 (0.2%) below 20% of the maximum dial range. A Certified Test Report is furnished without charge for applying corrections when instrument is used at accuracies higher than ½ of 1% of indicated reading.

PRECISION DRAWN TUBE—Drawn from phosphor bronze, beryllium copper, or 403 stainless steel—depending on pressure range. All tubes are specially treated to produce minimum hysteresis and drift.

PRECISION MOVEMENT—Aircraft quality for highest sensitivity. Nickel-dipped bronze with extra long bearings and heavy bronze bushing fitted with nickel silver pinions and arbors.

PRECISION CALIBRATION—Graduations are individually hand-spotted and engraved on a white background. Dial may be rotated 10° for zero adjustment to compensate for preloading.

DIAL SIZES—12" and 16".

PRESSURE RANGES—All pressure ranges from 30" Vacuum and 15 to 20,000 p.s.i. Ranges over 30,000 p.s.i. on special order. Suppressed scales available on request.

CASE AND RING—Cast aluminum case, black finish. Cast brass ring with polished chromium finish. Flush panel mounting or surface mounting with back or lower connection.

For additional information, write for USG Catalog 64.

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

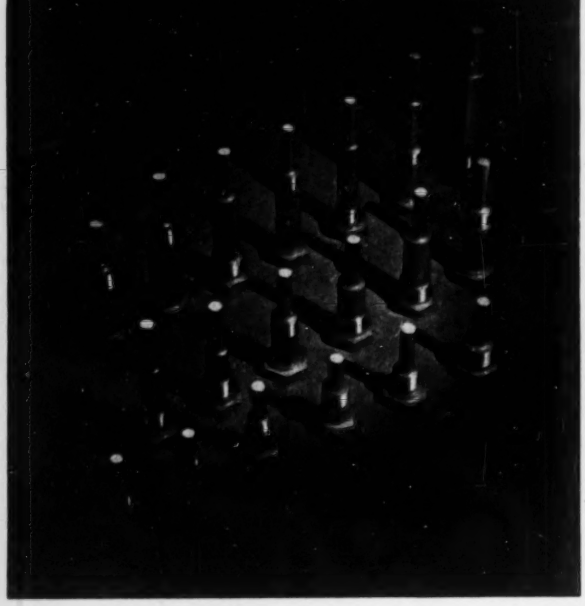
Quality Gauges Engineered for Enduring Accuracy **UNITED STATES GAUGE**

PRODUCTS OF UNITED STATES GAUGE . . . Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

For more information circle **15** on inquiry card.

You can depend upon
MOELLER ACCURACY



. . . to safeguard
PROFITABLE PRODUCTION

. . . for Moeller Thermo-wells, Thermo-couple protecting wells and separable sockets are actually weapons of industry. They help conquer the baffling problems of scientifically testing temperature readings and recordings, as well as making possible the most intricate types of thermometer installations.

Produced on specially designed equipment, these precision parts are drilled true and are concentric with the outside diameter. The surfaces are machined and tooled to the closest tolerance to permit maximum speed of response to temperature changes. Made in various alloys.

Send for catalogs and literature on

INDUSTRIAL, LABORATORY
AND RECORDING THERMOMETERS
VACUUM GAUGES • HYGROMETERS
HYDROMETERS • PSYCHROMETERS
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MOELLER
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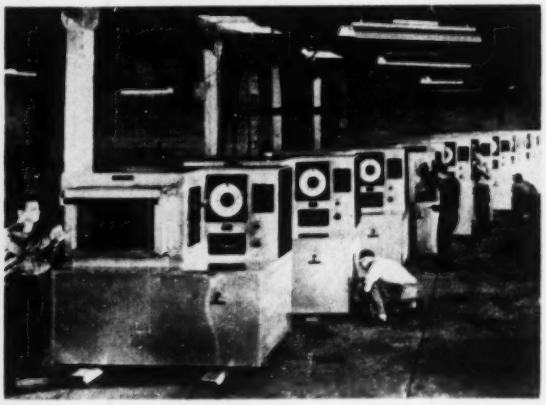
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

For more information circle **16** on inquiry card.

tery of instruments and controls to record results of the split-second runs. Oscillographs record the output data. Amplifiers at right and balance boxes at left feed information to the oscillographs. Accelerometers and strain gages are used to pick up information. The control panel at the far right is set to provide pre-determined acceleration forces.

Stratosphere Chambers

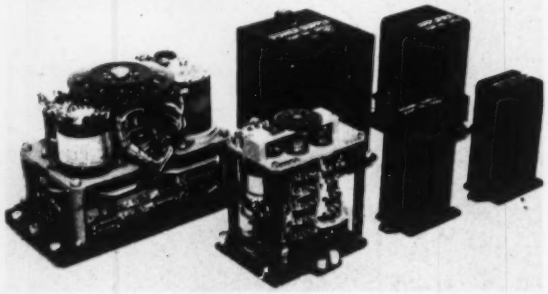
UNION, N. J.—Twenty-one stratosphere chambers, said to be the largest number ever contracted for at one time, are now being shipped from Tenney Engineering's plant



in Union, N. J. Ordered by the Gentile Air Force Base, the chambers will be assigned to domestic and overseas Air Force depots for testing and calibrating aircraft instruments in maintenance and repair operations. The test chambers have a temperature range from –75 to 75 C.; and an altitude range from –1000 to 80,000 ft. Overall dimensions are 4 x 6 x 7 ft.

Product Redesign

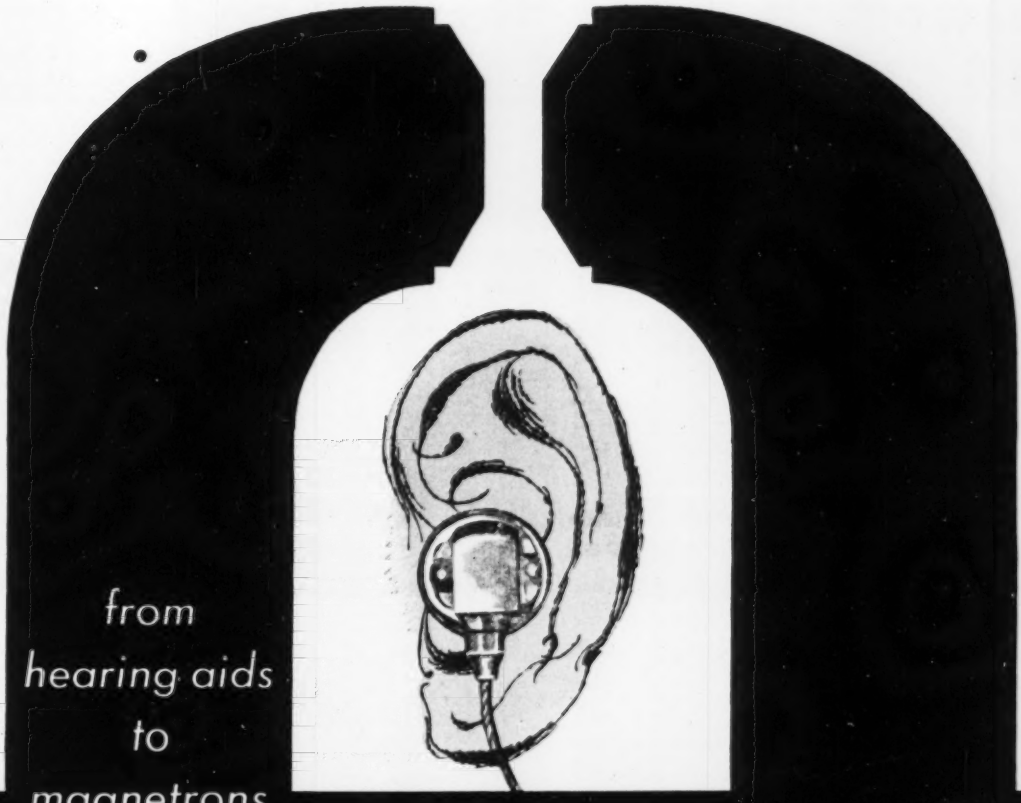
LONG ISLAND CITY, N. Y.—Redesign of an aircraft fire control computer resulted in weight reduction from 12½ to 3½ pounds, increased the number of computations performed, reduced cost, and improved performance and reliability. Collaboration of Servomechanisms, Inc. and



Electro-Mec Laboratory, Inc. produced a system of standardized "package servo components" (made by Servomechanisms) and ultra-low-torque-potentiometers (made by Electro-Mec).

The illustration shows a comparison of the original servo units in the background and the redesigned units in the foreground. Use of ganged Electro-Mec ultra-low-torque potentiometers permitted reduction of 40 percent in power required for the miniature servo motor which drives the potentiometers.

A typical aircraft computer of this type provides outputs



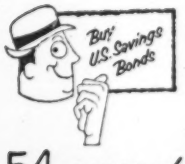
from hearing aids to magnetrons

CRUCIBLE PERMANENT MAGNETS

provide consistently higher energy product

When buying or specifying permanent magnets, consider these Crucible advantages. Crucible alnico permanent magnets are made to meet practically any size requirement from 0.01-pound hearing aid magnets to several-hundred-pound magnetron magnets—and everything in between. Crucible magnets are sand cast, shell molded or investment cast to meet your every size, tolerance, shape and finish need. And their magnetic quality is unsurpassed . . . they *consistently* provide the maximum energy from a minimum volume of magnet material.

Since alnico alloys were first developed, Crucible has been a leading producer of this superior type of permanent magnet. So for technical assistance in solving magnet application problems, don't hesitate to call Crucible. And if you are interested in either *Magnet Design* or *Data on Permanent Magnet Alloys*, write for a free copy on your company letterhead.



CRUCIBLE first name in special purpose steels

54 years of *Fine* steelmaking **ALNICO PERMANENT MAGNETS**

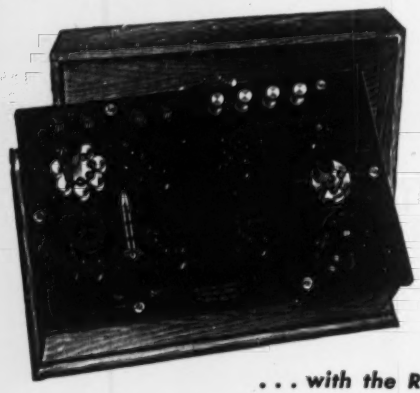
CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA

STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

For more information circle **17** on inquiry card.

Precise

TEMPERATURE MEASUREMENTS

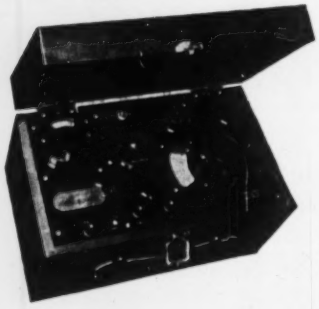


. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



. . . with the Rubicon
PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

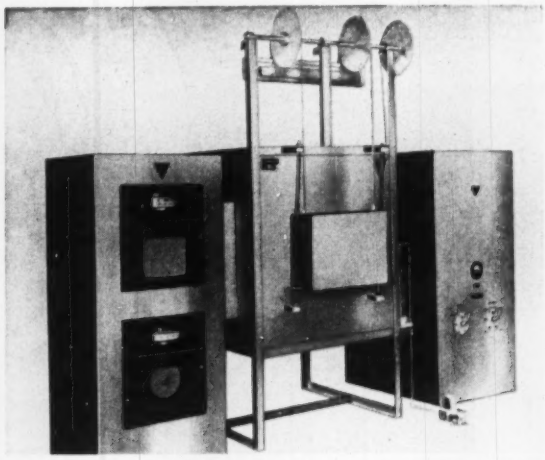
RUBICON COMPANY
Electrical Instrument Makers
3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **18** on inquiry card.

of such quantities as mach number, altitude, true airspeed, angle of attack and drift, air density, etc. One such computer now in production at Servomechanisms, Inc. supplies twenty three outputs, nine defining different quantities, and is the information center for the aircraft's fire control system and autopilot.

Furnace Control

COLUMBUS, OHIO—A complete time-temperature program controller is built into this new "FG-430" heat-treating furnace of the Pereny Equipment Co. of Columbus.



A Wheelco "Capacilog" provides continuous, automatic indication, control and permanent record of all temperatures up to 2700 F. to ¼ of 1 percent. The control system is made by Wheelco Instruments Div., Barber-Colman Company.

Automatic-control Terminology

NEW YORK, N. Y.—Standard terminology for the field of automatic control is being developed by a committee meeting under the auspices of the American Standards Association. The ASA was asked to initiate the project by the American Society of Mechanical Engineers which, with the American Institute of Electrical Engineers, has been investigating the terminology of the field. The ASME was elected to provide administrative leadership for the project, which is to be known as "Terminology for Automatic Controls."

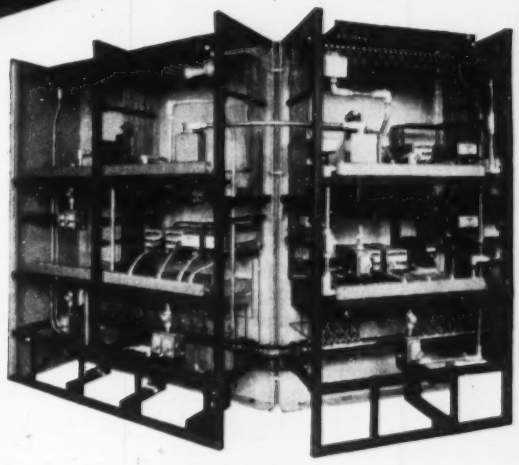
The Imperial Yard

TRAFALGAR SQUARE, LONDON.—Of historic interest is the "Imperial Yard," placed in Trafalgar Square, London, in 1876. Visitors will find it on the north side of the Square.

Creative Contributions
to Centralized
Process Control . . .

GRAPHIC PANELS

by FOXBORO



Typical back-of-panel view. Note open framework construction (easily enclosed if desired), terminals tagged for quick identification in field, neat arrangement of tubing and wiring, full accessibility to all instruments.

Years of experience in panel design and construction have equipped Foxboro Panel Engineers with many exclusive techniques . . . methods which bring you unequalled performance in centralized process control.

One typical feature is the use of aluminum strips and shapes, three-dimensional in effect, in bright, permanent colors, to symbolize flow lines and vessels. These are securely attached over the background finish, yet may readily be rearranged when necessary without marring the finish or leaving ugly holes. (If you prefer, painted graphic panels can be furnished.)

Behind the panel, Foxboro's open framework construction and the neat, clean arrangement of piping and wiring permit quick installation and far easier maintenance.

Foxboro's skilled Panel Assembly Department completes the team which provides you with the most efficient and usable Graphic Panels available today. Let us work up a detailed proposal for you.

The Foxboro Company,
467 Neponset Ave.,
Foxboro, Mass.

FOXBORO
Reg. U. S. Pat. Off.
PROCESS CONTROL ENGINEERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle **19** on inquiry card.

designer's INSTRUMENT guide

FOR PRODUCTION MACHINES – WESTON "per-cent load" ammeters and wattmeters make it easy for operators to secure optimum production from lathes, milling machines, automatics, grinders, etc. Prevent overloading – reduce tool breakage – assure uniform quality with fewer rejects. Other scale calibrations also available.

FOR ELECTRONIC EQUIPMENT – WESTON panel instruments are available in 1½", 2½", 3½", 4½" and 5½" sizes in all required ranges and types, including d-c, a-c, rectifier and thermocouple types. Approved ruggedized and sealed instruments available in all types in 2½" and 3½" sizes. Special panel bulletins give complete information.

FOR RPM MEASUREMENTS – WESTON electrical tachometer indicators are available with scales calibrated in RPM, or any function of RPM, such as feet per min. – pieces per hour, etc. Indicators can be mounted remotely; and if required, more than one indicator can be operated from one generator. Special compact, lightweight a-c and d-c generators permit wide flexibility in mounting and connection arrangements. Directly indicate speeds from 1 RPM to 40,000 RPM or higher.

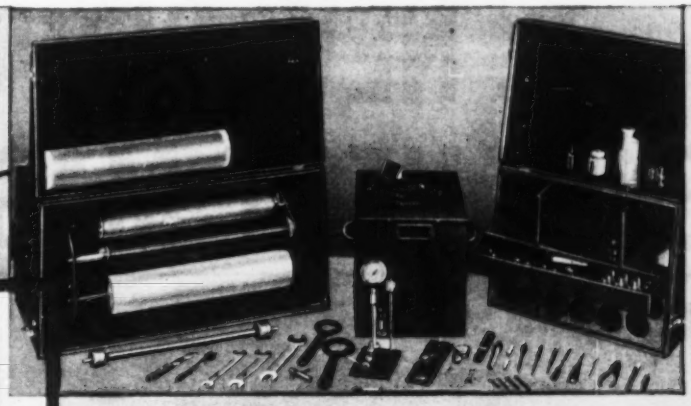
FOR TEMPERATURE MEASUREMENTS – WESTON Bi-metal thermometers are rugged and dependable, and are readily adaptable for built-in needs. Available in angle and straight stem types, stem lengths from 2" to 72", scale lengths 3.40" to 9", ranges low as −100°F. and high as +1000°F. Corrosion resisting stainless steel stems – accuracy 1% of thermometer range.

6402

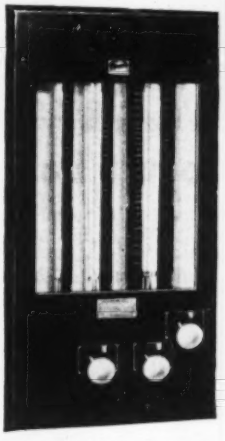
Literature on any of the above instruments sent on request.
WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

For more information circle **20** on inquiry card.



Cox Type 7
Direct Pressure Engine Indicator



Cox Type 12
Multiple Stage Flow-Meter

GOOD INSTRUMENTS ARE ALWAYS GOOD INVESTMENTS

Cox Type 309 Direct Weight
Method Flow-Meter Calibrating Stand

. . . and Making GOOD INSTRUMENTS Has Been Our Business For Over 40 Years

WHAT ARE *Your* TESTING PROBLEMS?

If your particular testing problem involves flow rate measurement or some similar phase of hydraulics requiring special equipment, we invite you to submit your problem to us for research and study. A description of the process involved and all pertinent specifications should be included. If in the opinion of our hydraulics engineers the basic idea is practical, we will undertake design and development of the special equipment.

DESIGNING and building Cox Precision instruments has been the full time job of Commercial Research Laboratories, Inc. for over *40 years*.

The experience and specialized "know-how" we have gained is evident in the great number of Cox instruments currently being used by the automotive and aircraft industries, and by the U.S. Airforce, Army, and Navy.

Today, as in the past, scientists and craftsmen here at Commercial Research Laboratories are hard at work developing new and improved Flow-Meters, Flow-Meter Calibrating Stands, Fuel Nozzle test stands, and other Cox precision testing devices to help you in meeting tomorrow's testing problems. At the same time, we stand ready to help in designing and building the accurate precision instruments your *immediate* testing problems require — whether for the research laboratory or the production line.

An example of modern CRL service is a flowmeter service department which we have just created. Using Cox Calibrating Stands, we are able to test any make or capacity flowmeter to determine to what *exact* percentage the instrument is accurate. In cases where design of the instrument will not allow re-calibration, correction curves can be supplied to guide users in future operation of the instrument.

Commercial Research Laboratories, Inc.

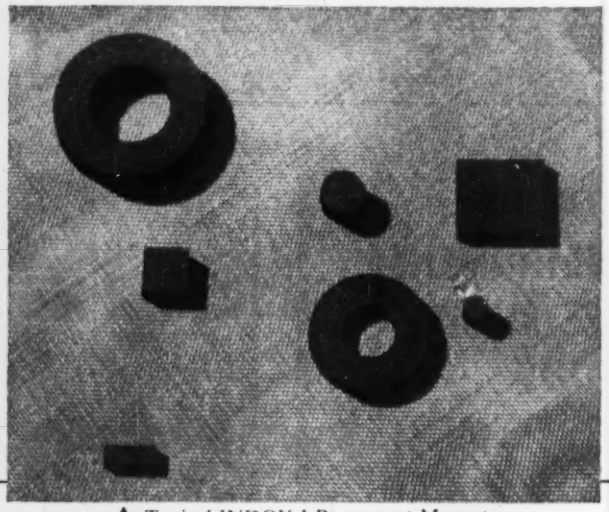
20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

MAKERS OF REGISTERED TRADE MARK **SINCE 1912: SINGLE AND MULTIPLE STAGE FLOWMETERS • FLOWMETER CALIBRATING STANDS • CARBURETOR FLOW STANDS • FUEL NOZZLE TEST STANDS • ENGINE INDICATORS • MAGNETIC THICKNESS GAGES • VIBRATION RECORDING EQUIPMENT BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS.**

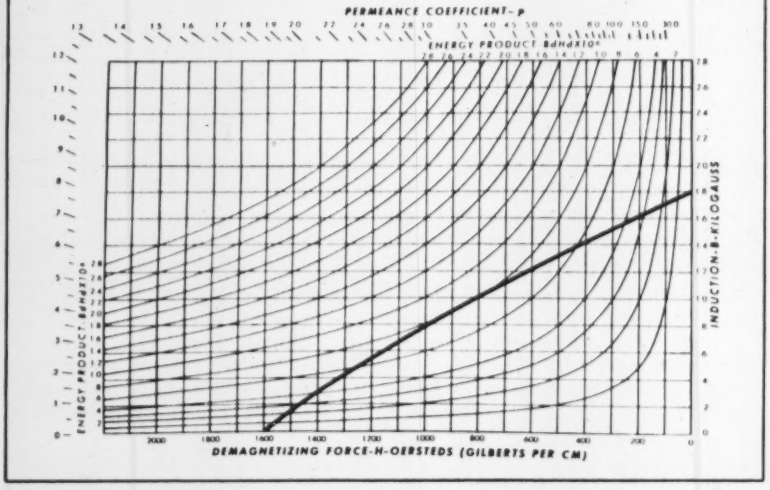
For more information circle **21** on inquiry card.

Presenting INDOX I . . . A

NEW CERAMIC PERMANENT MAGNET



▲ Typical INDOX I Permanent Magnets



▲ Demagnetization and Energy Product Curve for INDOX I

. . . Opens New Fields for Product Designs

INVESTIGATE THESE CHARACTERISTICS

- Higher coercive force than any other commercial permanent magnet material.
- Negligible hysteresis and eddy-current losses in magnetic circuits having an alternating-current component.
- High electrical resistivity.
- No critical materials required.
- Lightweight.
- Magnetization practical prior to assembly.

Let our forty-three years of accumulated permanent magnet experience help you to utilize this new magnet in your products. Write to Dept. 7D for complete details.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

For more information circle **22** on inquiry card.

ACHIEVED!

A Scanning System That Instantly, Graphically Presents All Process Variables

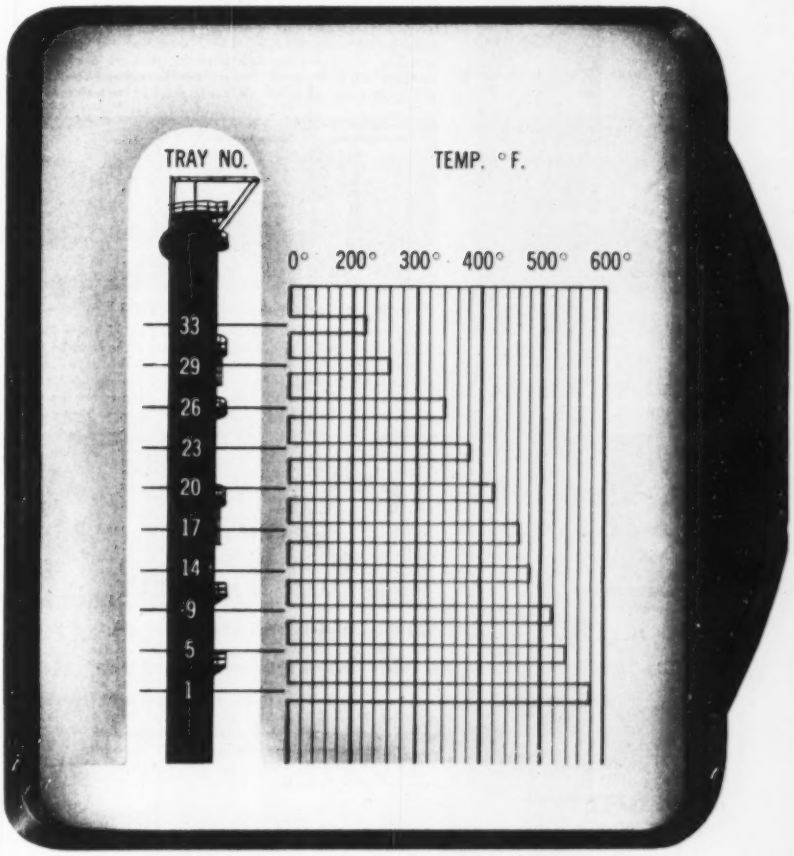
Now! Higher speed scanning than ever before with the Kybernetes Electronic Scanning System.* Permits graphic representation of all variables on scope. You see and hear your process operation.

Completely electronic. Scans each of any number of points 60 times per second. You secure uninterrupted scanning, continuous protection and alarm indication throughout logging, recording, and point reading. There is continuous qualitative and quantitative scope display of all process variables. The Kybernetes Electronic Scanning System is readily miniaturized and JANized for airborne and other equipment.

Transmitters, 8″ x 8″ x 12″, are packaged in convenient 4 point plug in units.

You may use the Kybernetes Electronic Scanning System to more efficiently and effectively monitor temperature, flow, level, pressure, viscosity, pH, concentration, conductivity, radiation, gas analysis, and other process variables.

For Specific Information applicable to your own monitoring requirements, write today.



This illustration shows just one of many Kybernetes Electronic Scanning System applications: signal sources from trays of fractionating column. Two or more trains of pulses may be simultaneously exhibited on one viewing tube.

The KYBERNETES Corporation · DIVISION OF SELF WINDING CLOCK CO., INC. (*PATENT PENDING)

1100 RAYMOND BOULEVARD, NEWARK 5, NEW JERSEY (OPPOSITE PRR STATION)

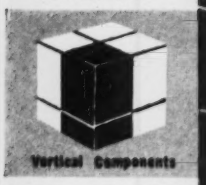
For more information circle **23** on inquiry card.

1 IN Complete Telemeter PACKAGE

BY BENDIX - PACIFIC

These compact, rugged FM/FM telemetering packages are available for many types of applications. Numerous models of plug-in subcarrier oscillators and associated components are available as standard equipment to provide for maximum versatility and efficiency.

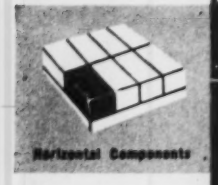
CUBICAL CONFIGURATION

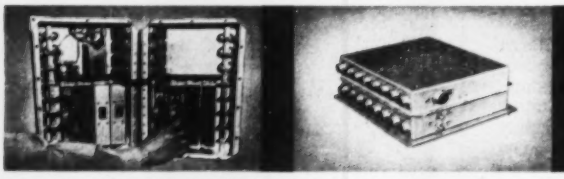


Compact Four Band Telemeter, Models TATP-3 and TATP-4

These packages, each incorporating four plug-in subcarrier oscillators, when used with a power supply and RF transmitter, form a compact, rugged system for telemetering various functions. Each package contains its own voltage regulator and calibration relays. The packages may be combined to form an 8 or 12 band system. Each package measures approximately 4.5" in each dimension and weighs approximately 3 pounds including oscillators. Standard power supplies are available for operating up to 3 packages and a 2 watt RF transmitter. The model TATP-3 operates in any 4 of the RDB bands below 22 kc; the TATP-4 in any 4 of the bands from 22 kc up.

RECTANGULAR CONFIGURATION

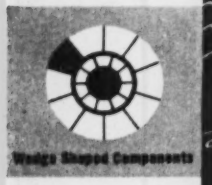


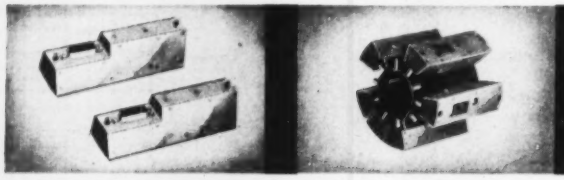


Universal Eight Band Telemeter, Model TATP-2

Operates on any eight RDB bands from 1.7 to 70 kc permitting any combination of 8 resistance, voltage or inductance type measurements to be made by merely plugging in the proper subcarrier oscillators. The unit has provisions for mounting a model TXV-13 crystal controlled transmitter. Connectors are provided for a minimum of eight remotely located pickups. Standard power supplies are available for operation from 6, 12, 28 VDC or 115 VAC 400 cps power sources. Dimensions—14" x 12.4" x 4.75".

CYLINDRICAL CONFIGURATION



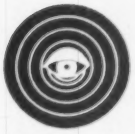


Cylindrical Telemeter Configuration, Model TJW-1

These packages are built up of individual 30° wedge shaped components which plug into a cylindrical mounting assembly, Model TJW-1. As many as 10 subcarrier oscillators or other components can be installed into a 6.5" circular opening, 5.5" long. A center opening, approximately 1.5" in diameter, can be utilized for cables and pressure lines. A two-watt crystal controlled RF transmitter is also available for mounting in this configuration.

Write for Complete Information

RADAR



SONAR

HYDRAULICS

TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS

BENDIX PACIFIC

THE NAME Bendix AVIATION CORPORATION MEANS RELIABILITY

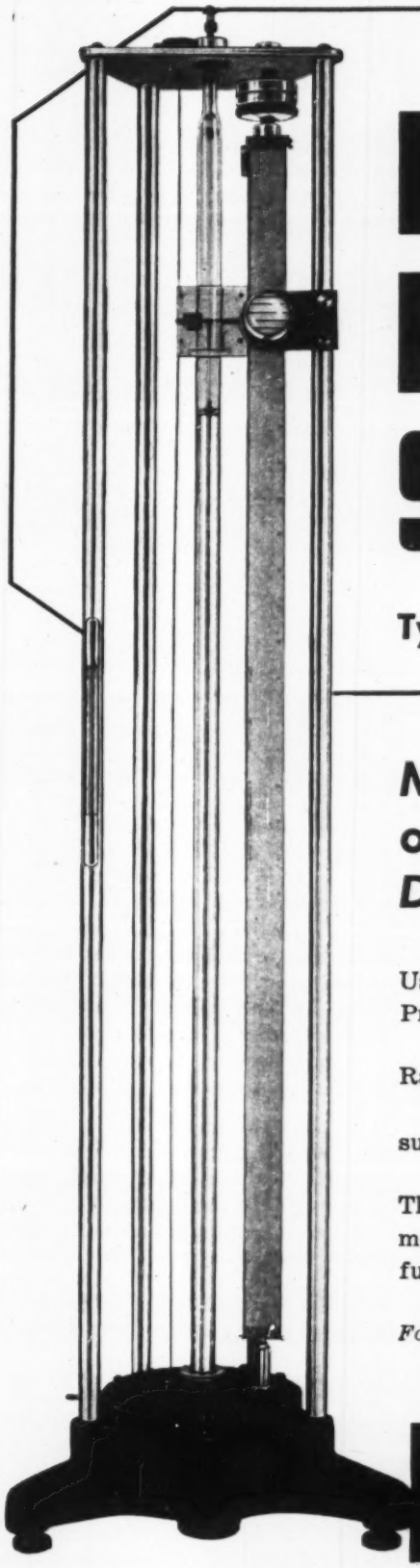
PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

East Coast Office: 475 5th Ave., N.Y. 17

Export Division: Bendix International 205 E. 42nd St., N.Y. 17

Canadian Distributors: Aviation Electric, Ltd., Montreal 9

For more information circle **24** on inquiry card.



MERCURIAL-PRECISION STANDARD

Type FA-187

Measures *Absolute* or *Differential Pressure*

Used interchangeably as a Barometer or Differential Pressure Manometer.

Range: 0 to 800 mm of Hg.
0 to 31.5 in Hg. or in any other desired pressure unit of equivalent range.

The magnetic vernier reads to 0.01 mm or 0.005 in. of mercury with an accuracy of 1 part in 5000 over the full range.

For additional information,
write for Publication Number TP-32-A.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST. BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

A-103

For more information circle **25** on inquiry card.

CRESCENT ARMORED MULTITUBE

Readily Installed in Conduit

CRESCENT ARMORED MULTITUBE can be easily pulled into and removed from runs of conduit with up to two 90° long radius elbows. This is a decided advantage where at some later date a different number of tubes may be needed to replace those first installed.

While CRESCENT ARMORED MULTITUBE is adequately protected for all practical purposes by the interlocked steel armor, the additional protection afforded by conduit is often advisable where tubing is to be run through heavy foundations or in places where it might be subject to unusual mechanical abuse.

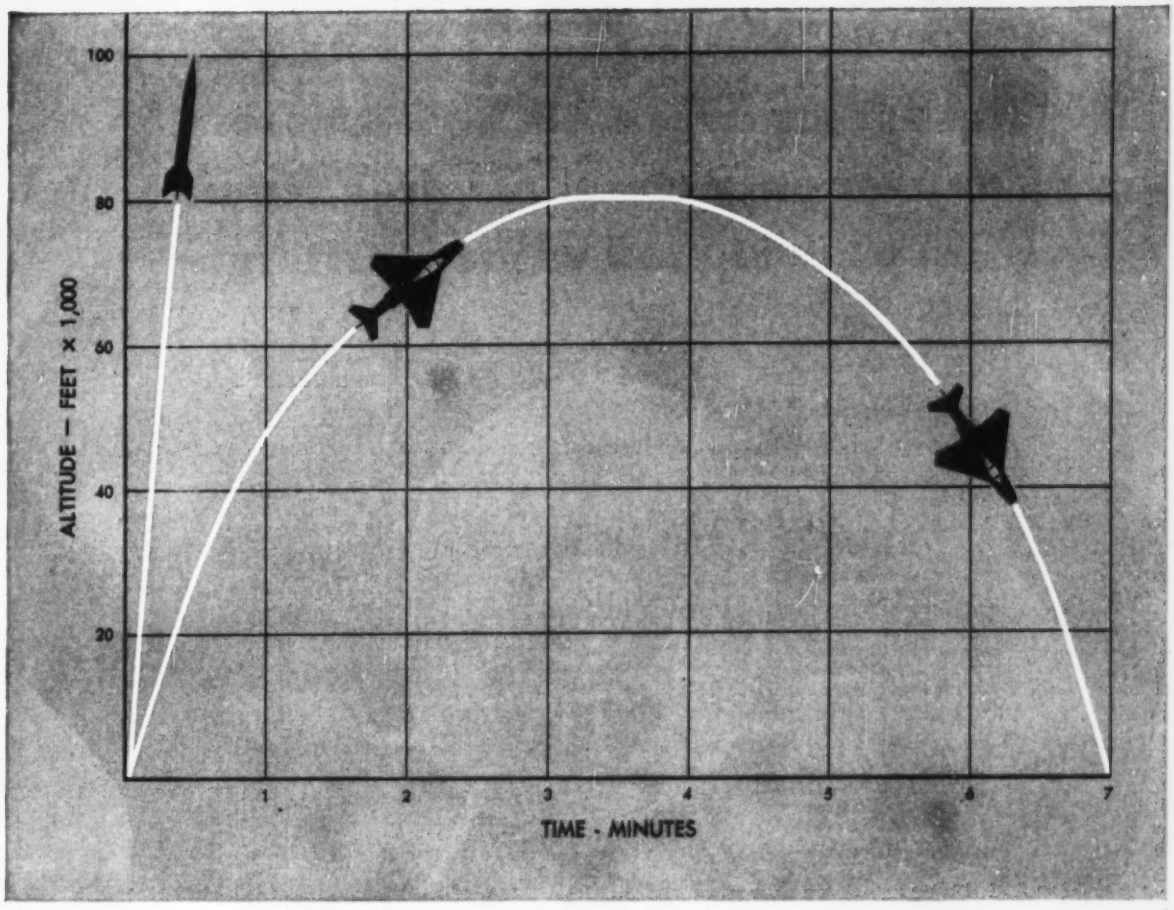
CRESCENT ARMORED MULTITUBE consists of long length tubes of copper, aluminum or polyethylene, cabled together to permit bending without distortion of the tubes. The spirally cabled tubes are protected by a tape and flexible, interlocked galvanized steel armor.

One tube in each layer has a bright blue color, which permits a ready identification of each tube at both ends. Long, continuous lengths up to 1,000 ft. save waste and short ends. Licensed under U.S. Patent 2,578,280.

SEND FOR BULLETIN GIVING COMPLETE INFORMATION AND ENGINEERING DATA.

CRESCENT
Insulated Wire & Cable Co.
TRENTON, N. J.

For more information circle **26** on inquiry card.



Sea Level to 80,000 Feet *in Three Minutes*

One of the many successful applications of Hagan Automatic Control is simulating flight conditions for testing jet engine components.

The automatic control system changes test chamber pressure (on a programmed basis), from sea level to 80,000 feet in three minutes. The program can be stopped at any altitude setting, for automatic control of a steady test chamber pressure.

For this installation, a programmed pneumatic signal dictates test chamber pressure to a regulator for conversion into a controlling signal to a hydraulic pilot valve. This, in turn, directs high pressure oil to a linear travel power unit for extremely fast and accurate operation of the controlling damper.

This Is Important

The same Hagan Automatic Control System is ready now for simulating flight to 80,000 feet in six seconds.

With the equivalent system utilizing Hagan electronic control elements, programmed trajectories from sea level to 100,000 feet in three seconds are obtainable.

HAGAN
HALL
BUROMIN
CALGON

Hagan Corporation

AERONAUTICAL AND SPECIAL PRODUCTS DIVISION
HAGAN BUILDING, PITTSBURGH 30, PA.

Control Systems for Automotive and Aeronautical Testing Facilities
Ring Balance Flow and Pressure Instruments
Metallurgical Furnace Control Systems
Boiler Combustion Control Systems

For more information circle **27** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

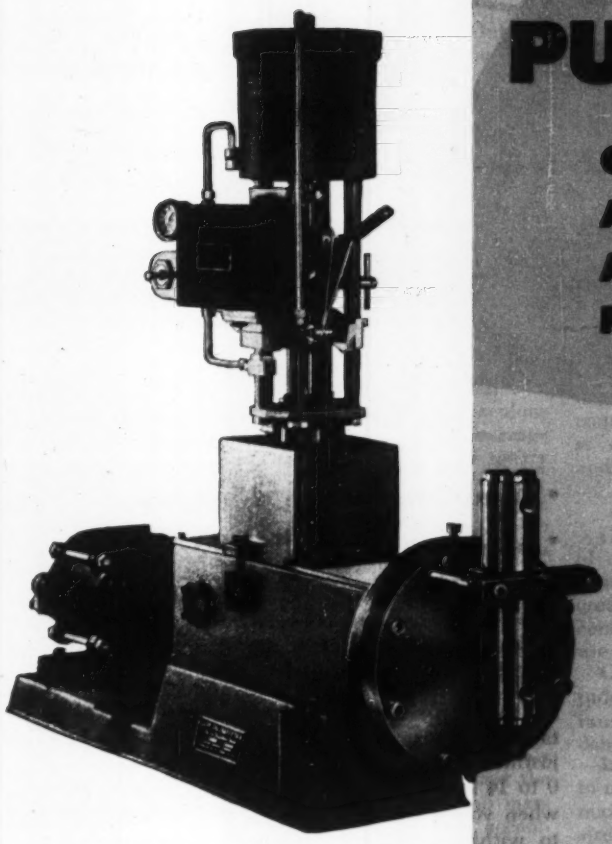
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

NOW!

Lapp *Auto-Pneumatic* PULSAFEEDER

OPERATES AT FULL CAPACITY AND FULL RATED PRESSURE

The Lapp Auto-Pneumatic Pulsafeeder has made possible automatic continuous processing in many processes involving chemicals or mixtures which have not been satisfactorily handled by pumps of conventional construction. In this construction, pumping rate is controlled by instrument air pressure responsive to variable flow, pH, temperature, liquid level, pressure, or any other instrument-measurable processing variable. And now, new improved Auto-Pneumatic instrumentation provides for greater capacity and/or pressure—full ratings as listed for manually-controlled models.



TWO PUMPS IN ONE!

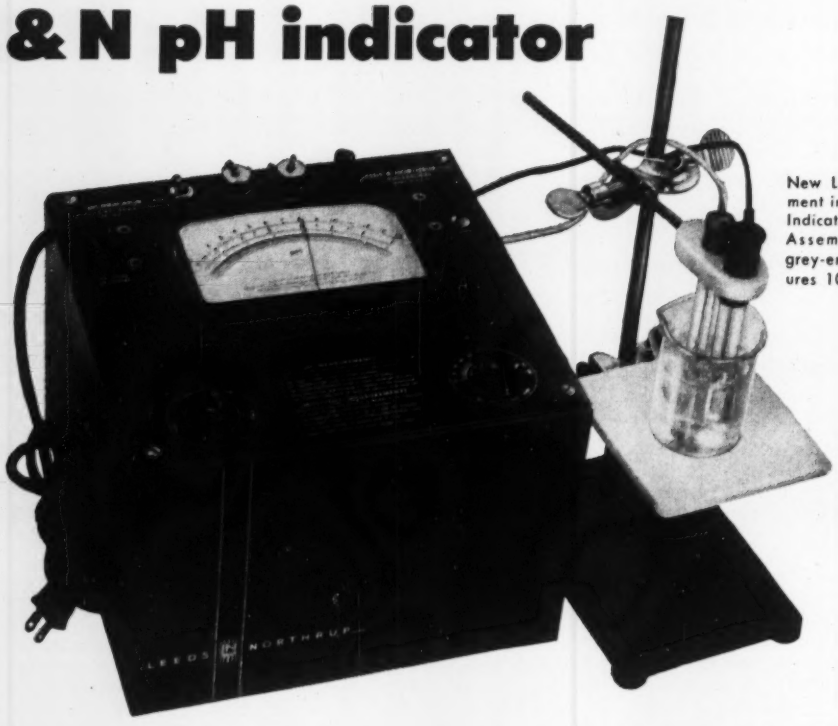
Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Constant pumping speed; variable flow results from variation in piston-stroke length —controlled by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

WRITE FOR BULLETIN 300 with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 375 Wilson St., Le Roy, N.Y.

For more information circle **28** on inquiry card.

Stabilized

L&N pH indicator



New L&N pH Indicator. Equipment includes: line-operated pH Indicator and Electrode Holder Assembly. Indicator case, of grey-enameled aluminum, measures 10½" x 10¼" x 8⅜".

Check these distinctive L&N advantages...

- ✓ **Continuous 5½" scale**—covers full range of pH 0 to 14 . . . readable to ±0.02 pH.
- ✓ **Electrode system**—takes any suitable type . . . but circuit especially designed for high resistance glass electrode systems.
- ✓ **Grounded or ungrounded solutions**—can be checked with equal ease and accuracy.
- ✓ **Only 2 controls, 1 switch**—standardization and temperature-millivolt controls . . . zero switch.
- ✓ **4 voltage ranges**—0 to +700, 0 to −700, 0 to +1400, and 0 to −1400 mv . . . for redox work and Karl Fischer Titration measurements.
- ✓ **Fast warmup**—not more than 1 minute.
- ✓ **Short response time**—1.5 seconds . . . for most readings.

• eliminates range changing

• readable to within±0.02 pH

This *converter-type* pH Indicator offers remarkable stability. Embodying important refinements in circuit design, it is unaffected by normal fluctuations in line voltage . . . or by zero drift of the amplifier.

In lab or plant—you'll appreciate the many advantages of this new instrument. The few required adjustments are simple to make. Single, *continuous* pH 0 to 14 scale eliminates range changing . . . a big help when you're working near pH 7. And you can read to within ±0.02 pH . . . on either grounded or ungrounded solutions.

Key to stability: the Indicator incorporates the high quality shielded *converter* developed for our Speedomax electronic recorders. Its circuit employs d.c. to a.c. conversion, a.c. amplification, and conversion back to d.c. for voltage feedback. Conversion stabilizes zero. Feedback stabilizes gain.

For details—send for Folder EM9-96(1). Write 4955 Stenton Ave., Phila. 44, Pa.

LEEDS NORTHRUP

For more information circle **29** on inquiry card.

EDITORIAL COMMENT—

Condensation of a talk by RICHARD RIMBACH before the Annual Dinner of the Sarnia Section of the Instrument Society of America, May 28, 1954.

Economic Considerations of AUTOMATION

AUTOMATIC PRODUCTION involves a philosophy of consumption more than of production. It is consumption which promotes mass production and releases the miracle of high wages and low costs that are inherent in our economic way of life. Purchases and consumption are the ruling factors in our economy. Only as consumers can we remain producers; we consume our way to security and prosperity.

The consequences of accepting a philosophy of consumption can be enormous, and they involve not only ordinary business activity but government policy as well.

Development

As our country grew in population, the demand for goods stimulated methods of increasing production. Increased demand for goods stimulated better methods of production.

As time went on, the rate of conversion of raw materials into finished products and the volume of these finished products represented an astounding performance. However, the most significant contribution made by our system of production, and a true standard of its miraculous nature, was the reduction in the *amount of the average man's laboring time required to earn the goods to satisfy his needs and desires.*

There is only one fair measurement of price for the individual in an economy: How long does it take him to earn a pair of shoes, a suit of clothes, a loaf of bread, a television set, an automobile or a home? There can be endless arguments about quality of goods and about the value of the amount of each nation's currency paid for labor and demanded for every product. But the arguments are reducible to a minimum if we make and study comparative lists of products in terms of the working time necessary for their purchase. Thus we reduce the exchange of work for goods to the simple barter of time for goods earned. Bread and meat that can be obtained with less than an hour's work in America may elsewhere cost the labor of a full day if they are available at all, and mass production is the medium which permits this accomplishment.

Basis for Mass Production

For the development of mass-production methods, there are three essential ingredients—standardized parts, venture capital, and effort by both management and labor. None of these are new ideas; but what is new is the accelerated production resulting from "Automation, Instrumentation, Automatic Control." In part because of the original relative shortage of labor, industry sought to use man-hours as carefully and productively as possible; there was thus an incentive to supplement manpower with the horsepower of machinery. As a result, despite relatively high hourly wage rates, it became possible to create goods at low unit labor costs, through greater productivity of each man-hour of labor. With increased productivity, man's working time produces more goods either at lower costs with the same wages or at the same costs with higher wages—but always with increased real wages—because each unit of a man's working time makes possible the procurement of more goods.

—But, the productivity of the automatic machine is not automatic. It depends on the purchase and use of its product.

Mass production can only be maintained at its peak when its appetite can be fully and continuously satisfied. To maintain this continuity, it is absolutely necessary that the products that roll from the assembly lines of mass production be consumed at an equally rapid rate, and not be accumulated in inventories. Mass production can maintain unbroken activity only if it is continuously accompanied by mass markets.

Consumption, not production, is the master of our economy. Mass markets are impossible without mass production, but there is no reason to believe that industry will ever prove unable to produce goods in as large quantities as the public is desirous of consuming.

Necessary Conditions

In a system of competitive enterprise, mass production depends on one of two conditions: either the growth of employment through a rise in the consumption level—that is, an improvement in the standard of living—or more and more government activity to provide employment.

Consumer Credit

Closely related to demand and income in the development of mass markets is an attitude in which Europeans and Americans differ: the attitude toward the use of consumer credit. In America the development of mass markets for consumer goods has been inseparable from the increasing use of consumer credit.

Credit is given consumers because, in the creditor's best judgment, the debtor's probable earnings and honesty warrant the confidence which credit implies. The fact that debtors sometimes have to redouble their productive efforts —keep their noses to the grindstone, as it were—in order to meet credit obligations merely shows the link which this marketing practice serves in connecting the awakened desire to the individual capacity to satisfy that desire. Consumer credit is the instrument which may furnish the hope of a consumer to attain the standard of living which he desires. Credit is an effectual and sound device for the creation of mass markets.

It is one thing to achieve the capacity to produce for the masses and another thing to create mass markets through stimulation of demand, distribution of adequate purchasing power, and the judicious use of credit. It is still something else to develop a distributive system capable of disseminating the products of mass production to mass markets.

All these factors enter into the mass-consumption system. Mass production makes low-cost goods available; but only mass consumption makes mass production possible. We who devote all our efforts to complete automation of production processes, to the production of greater quantities of cheaper and better products, should not lose sight of the fact that our entire economy rests on a foundation of mass consumption.

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1113

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PROCESS CONTROL

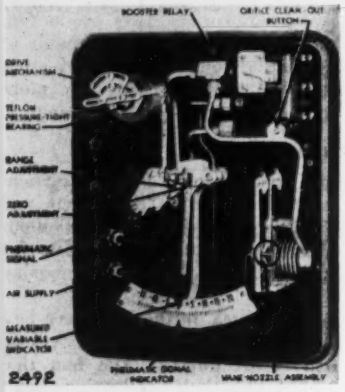
10- and 20-point Recorders

Two new electronic strip chart recording instruments are designed to record 10 and 20 points. Latter yields 25 percent more data than 16-point recorders without a proportionate increase in either size or maintenance expenses.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **201** on inquiry card.

Universal Transmitter

New transmitter for pneumatic telemetering and control systems transmits measurements of flow-rate, level, pressure, temperature, etc., as 3-15 or 3-27 psig. signals; up to 1000 ft. to



receivers, 400 ft. to controllers; accuracy within 0.5 percent; variable and signal both indicated on one scale.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*

For more information circle **202** on inquiry card.

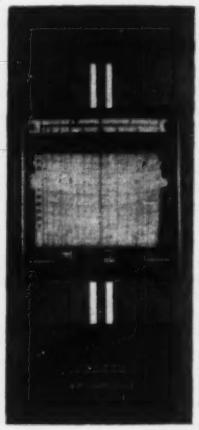
Ruggedized Contact-type Automatic Controllers

New models of "Meter Relays" are available in ruggedized and sealed construction. They withstand 50-*G*

shock and 10-to-55-cps. vibration of 0.03-in. amplitude. Two sizes: 2½ and 3½ in.—*Assembly Products, Inc., P.O. Box 191, Chagrin Falls, Ohio.*

For more information circle **203** on inquiry card.

Receiver-Integrator

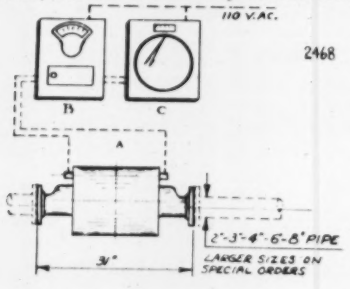


New "Type 224" receiver-integrator is a pneumatic-electric instrument for use with maker's "Consotrol" instruments (as in photo). It comprises a remote counter and a flow receiver. Counter can be mounted on front of panel. Flow receiver, comprising a receiver bellows and a cam-switch assembly, is housed in a small metal box behind panel. Two wires connect it to counter. Integrators are available for uniform or square-root scales to totalize minute, hourly or daily rates. Service calibration checks can be made during actual operation with no extra equipment required.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **204** on inquiry card.

Continuous Density Recorder or Controller

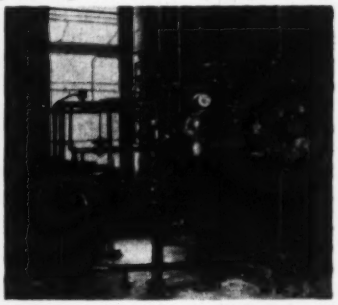
New "Densi-O-Meter" measures (and/or controls) density of slurries, solutions, or any fluid flowing in a pipeline; utilizes gamma-ray absorption and null method (with reference material) for stability and to permit choice of range by selection of reference; has automatic temperature compensation. A 100-division chart can represent a 0.1 density change (0.001 change per division). In diagram, A is measuring unit available in 2-in. to 8-in. pipe size, B is a Beckman amplifier and C is a Foxboro recorder (or recorder-controller).—*Sierra Industrial Instrument Co., 371 Fourth St., San Francisco 7, Calif.*



For more information circle **205** on inquiry card.

Endpoint Monitor

New "Enditrol" is first instrument for automatically indicating end of operating run of a hydrogen cation



exchanger (hydrogen zeolite) unit. Principle: continuous comparison of conductivities of effluent and of upstream sample; adjustable value of conductivity ratio which signals end of run. This signal may be used for full automatization of ion-exchange unit.—*The Permutit Co., 330 W. 42nd St., New York 36, N. Y.*

For more information circle **206** on inquiry card.

Mobile Mass Spectrometer

New "Model 21-620" mobile process monitoring and control type mass spectrometer utilizes a cycloidal-focusing principle; was developed for pe-

troleum, chemical and petrochemical industries; is said to "provide sensitivity, accuracy and wide range heretofore unknown in a mobile instrument of this type."—*Consolidated Engineering Corp., Pasadena 8, Calif.*

For more information circle **207** on inquiry card.

Telemetering System

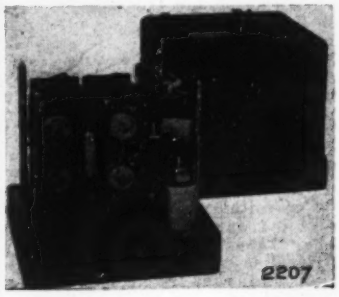
New "Telestep" telemetering system is the first one designed exclusively for automatic remote control of municipal and industrial water and

sewage equipment. It provides transmission for up to thirty signals in either direction between a transmitter and one or more receivers.—*Automatic Control Co., 995 University Ave., St. Paul 4, Minn.*

For more information circle **208** on inquiry card.

Telemetering Systems

New telemeter packages incorporate plug-in subcarrier oscillators which, when used with power supply and RF



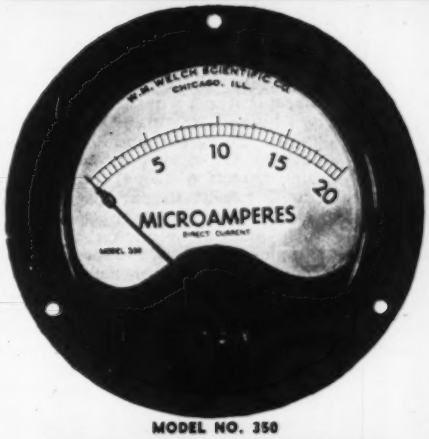
transmitter, provide FM/FM system for telemetering. "Model TATP-3" package operates in any 4 of RDB bands below 22 kc. "Model TATP-4" operates in any band from 22 kc up. —*Pacific Div., Bendix Aviation Corp., 11600 Sherman Way, North Hollywood, Calif.*

For more information circle **209** on inquiry card.

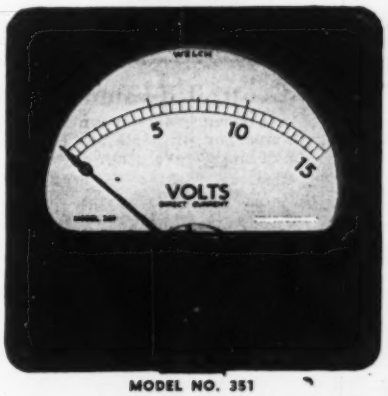
UV-type Gas Analyzer

New "Vapormaster" portable ultraviolet analyzer for measuring minute quantities of gas in air (in air pollution measurements, etc.) has a full scale absorbance of 0.0025 on its most sensitive range; can detect a few parts per billion, less than one-twentieth of toxic concentration, of many substances. "Vapormaster" is useful also as a

D. C. PANEL METERS
20 Microamp Meters



MODEL NO. 350



MODEL NO. 351

MODEL NO. 451

● *accuracy 2%*

Standard Equipment for many Radiation Devices, these Rugged, High Sensitivity Precision Instruments are the product of many years' experience in building Electrical Measuring Instruments.

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- Sapphire Jewel Bearings
- Selected Steel Pivots
- Fume-proof Metal Scales
- Extremely Rigid Mounting
- Sensitive Movement
- High Torque Ratio
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MODELS

350—3½ inch round—2.4 inch scale
351—3 inch square—2.4 inch scale
451—4½ inch rectangular—3.5 inch scale

TYPES

Microammeters 0-20 up to 0-500
Milliammeters 0-1 up to 0-500
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Voltmeters, various ranges, 100 to 50,000 ohms per volt
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DIGITAL COMMUTATORS

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CUSTOM COMMUTATORS

Commutators can be furnished to fit specific applications by either modification of standard models or wholly new designs. Some variations now available are:

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For more information circle **31** on inquiry card.

NEW INSTRUMENTS

system leak detector; is similar to instrument developed originally by V. F. Hanson of duPont.—*Manufacturers Engineering and Equipment Corp., Hatboro, Pa.*

For more information circle **210** on inquiry card.

UV-type Gas Analyzer

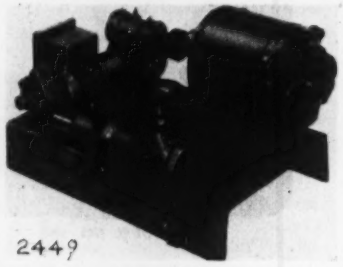
New "Supersensitive Gas Detector" utilizes mercury-vapor absorption in ultraviolet light to measure minute concentrations (as low as five parts per billion) of toxic or combustible gases. Unknown and reference gas samples are drawn through two parallel detection loops; each reaction chamber contains a charge of activated mercuric oxide which reacts with gaseous reducing material in sample to generate mercury vapor; photometric cells measure difference in mercury concentration between unknown and reference; output is fed to bridge and is indicated on calibrated instrument. Various models for laboratories, for tunnels, industrial areas, etc.—*Taller & Cooper, 75 Front St., Brooklyn 1, N. Y.*

For more information circle **211** on inquiry card.

FLOW AND VOLUME

Controlled-volume Pumps

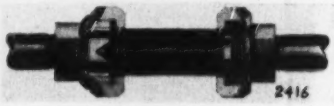
New motor-driven controlled-volume pumps for proportional feed systems have single-revolution clutch arrangement to permit one stroke in response to an electrical signal, to effect feed of an additive in proportion to main-line flow-rate. Signal may come from a positive-displacement meter, etc. Capacities from 0.125 to 1350 gph. against discharge pressures up to 50,000 psi.—*Milton Roy Co., Station Q, 1300 E. Mermaid Lane, Philadelphia 18, Pa.*



For more information circle **212** on inquiry card.

Water Flow-rate Controller

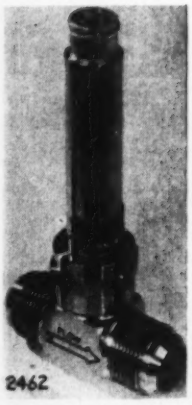
New "Mesurflo" for water lines maintains set flow-rate to 10-percent accuracy regardless of variable inlet pressures (15-150 psi.); compensates for surges in line pressure. Pressure drop is preset to deliver any constant rate between 0.2 and 14 gpm. Available in ¼-in., ⅜-in. and ¾-in. pipe sizes.—*Industrial Sales Div., Hays Mfg. Co., 816 West 12th St., Erie, Penna.*



For more information circle **213** on inquiry card.

Flow-rate Pickup

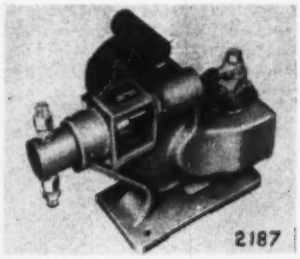
New "Mark V Flow Transducer" has no mechanically moving parts, utilizes a force-measuring principle with bonded-wire strain gages in a four-active-arm circuit. Features: ease of installation; no maintenance; exceptional speed of response; accuracy 0.5 percent; light weight (illustrated 1-in.-size unit weighs 1¾ lbs., is 7 in. high). Available in pipe and tubing sizes.—*Ramapo Engineering Co., Riverdale, N. J.*



For more information circle **214** on inquiry card.

Proportioning Pumps

New models of "Model 1105-S" proportioning pump increase its applications. It now is offered as either a 10-gph. or a 20-gph. pump with open or explosion-proof motors; in a variety of voltages; with either standard steel and stainless trim measuring cylinder assemblies or with measuring cylinder assemblies of 316 stainless steel and with ceramic plungers.—*Proportioneers, Inc., Providence, R. I.*

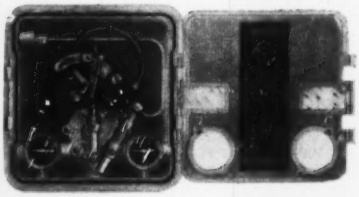


For more information circle **215** on inquiry card.

PRESSURE

Pressure Controller

New "Type 1440" non-recording pressure controller for pressure-vacuum control systems handles negative and positive pressures, from high vacuum to pressures up to 10,000 psi.; is Bourdon-tube actuated, with all settings calibrated, including vernier setting for fine adjustment. Proportional band and "on-off" or maximum-minimum snap action adjustments up to 75 percent of Bourdon tube rating.—*Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 3, Mo.*



For more information circle **216** on inquiry card.

Pressure Pickups

New "Series P100" pickups measure differential or gage pressures in non-corrosive liquids and gases. Ranges from plus and minus 1 psi. to plus and

minus 1000 psi. Principle: diaphragm displacement produces an inductance variation in a closely-spaced coil-core structure. Zero-drift and sensitivity change less than 3 percent from –40 F. to 165 F. Resonant frequency varies approx. as inverse square root of sensitivity and is about 2000 cps. in the 10-psi. sensitivity range.—*Datran Engineering Corp., 6312 W. 92nd St., Los Angeles 45, Calif.*

For more information circle **217** on inquiry card.

TEMPERATURE, HUMIDITY

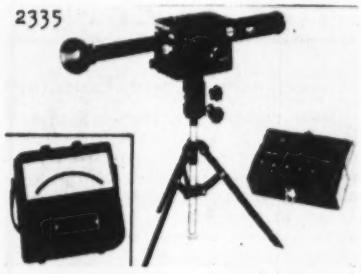
TC Extension Wire

New "Type PN" thermocouple extension wire has polyvinyl-insulated conductors and nylon (instead of cotton) as over-all insulation. Advantages: smaller diameter, up to 10 percent more wires can fit into conduits; smoother surface resists abrasion, easier to pull wires through conduits; easier to strip, no fibers to fray; lower initial cost.—*Thermo Electric Co., Inc., Saddle River Township, Rochelle Park Post Office, N. J.*

For more information circle **218** on inquiry card.

Optical Pyrometer

New "Pyro Micro-Optical Pyrometer" is capable of measuring temperatures (over 700 C. or 1300 F.) of targets less than 0.001 in. diam. and, by means of supplementary lenses,



can be adjusted for focal distances from 5 in. to infinity.—*Pyrometer Instrument Co., Inc., Bergenfield, N. J.*

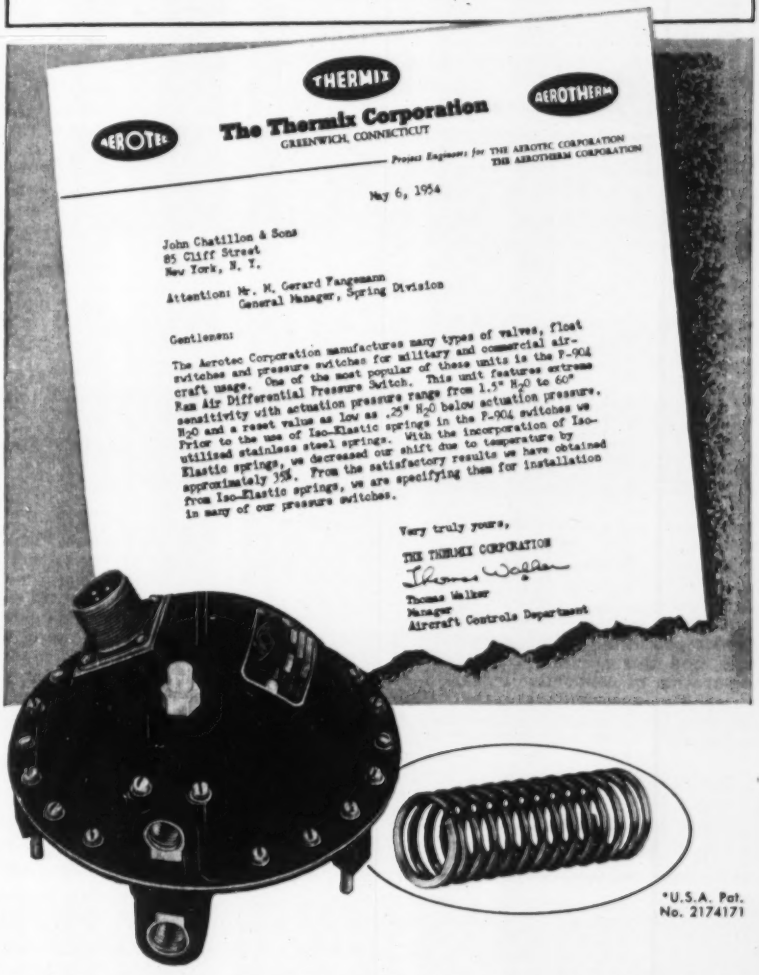
For more information circle **219** on inquiry card.

Tank Thermostats

New "No. 1449 Thermostat Valve" for temperature control on small storage tanks, kettles, etc., has metal ball inner valve seating tightly, preventing steam leakage. Hardened steel ball is not attached to stem, is free to rotate. Overstressing of bellows-type thermostatic system at over-range

CHATILLON

ISO-ELASTIC* SPRINGS REDUCE TEMPERATURE SHIFT 35% IN AEROTEC PRESSURE SWITCH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Gentlemen:
The Aerotec Corporation manufactures many types of valves, float switches and pressure switches for military and commercial aircraft usage. One of the most popular of these units is the P-904 Ram Air Differential Pressure Switch. This unit features extreme sensitivity with actuation pressure range from 1.5" H2O to 60" H2O and a reset value as low as .25" H2O below actuation pressure. Prior to the use of Iso-Elastic springs in the P-904 switches we utilized stainless steel springs. With the incorporation of Iso-Elastic springs, we decreased our shift due to temperature by approximately 35%. From the satisfactory results we have obtained from Iso-Elastic springs, we are specifying them for installation in many of our pressure switches.
Very truly yours,
THE THERMIX CORPORATION
Thomas Walker
Manager
Aircraft Controls Department

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Once again Chatillon Iso-Elastic has proven itself in an important application by increasing still further the accuracy of the Aerotec Corporation's P-904 Ram Air Differential Pressure Switch used in aircraft. With Chatillon Iso-Elastic springs, error due to temperature changes was reduced approximately 35%. This improvement in instrument efficiency was obtained after careful investigation by the Engineering staff of the Spring Division of John Chatillon & Sons, who successfully designed and produced the Iso-Elastic springs to meet exacting specifications.

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For more information circle **32** on inquiry card.

temperatures is prevented by an override spring. Five 50-deg. ranges from 25 to 275 F.; 50-deg. adjustment range. Sizes from ⅜-in. to 1-in.—*Klipfel Valves, Inc., Hamilton, Ohio.*
For more information circle **220** on inquiry card.

Temperature Controllers

New models of "Resireg" automatic temperature controllers, though largely using standardized components, are "tailor-made" to satisfy heat-transfer and other characteristics of each application; are claimed to "make possible control functions which heretofore were impossible." Primary elements are fast-response "Fuse-Din" resistance thermometers. Ranges from –450 F. to 3000 F.—*Weiller Instruments Corp., 95 Broad St., New York 4, N. Y.*
For more information circle **221** on inquiry card.

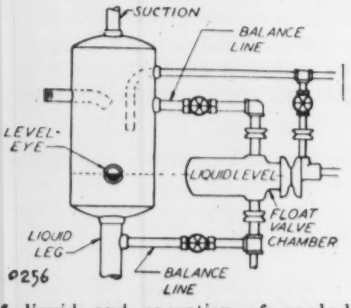
Fast Hygrometer

New electrical hygrometric system has novel primary element comprising a polystyrene film coated with carbon powder in a hygroscopic binder. Resistance increases with increasing relative humidity—not conversely as in devices utilizing conductivity of absorbed water. Reason: as humidity increases, increased water absorption by binder causes an increase in its volume and this swelling increases the separation of conductive carbon particles. Announcement states that "time lag has been reduced to less than a second at room temperature."—*Arthur D. Little, Inc., 30 Memorial Drive, Cambridge, Mass.*
For more information circle **222** on inquiry card.

LIQUID LEVEL

Liquid-level Viewer

New "Level Eye" permits checking inside pressure-sealed systems for liquid level, gas-liquid ratio, cleanliness



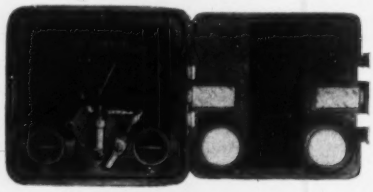
of liquid and operation of sealed valves and linkages. Temperatures limits –50 F. and 250 F.; pressures to 300 psig. (Special units for higher pressures; for low temperature systems, removable frost shield). Heat-tempered glass lens has a series of concentric reflecting prisms on liquid side: it reflects light where there is no liquid; liquid behind glass causes it to appear black.—*H. A. Phillips Co., 3255 W. Carroll Ave., Chicago, Ill.*
For more information circle **223** on inquiry card.

Liquid-level Transmitter

New differential converter, for measuring level of liquids in a closed tank, under pressure or vacuum, converts differential pressure into proportionate air pressure; utilizes a pneumatic balance weigh-beam system. Its range is field-adjustable from 0-14 to 0-200 in. water. Available with steel or SS bodies, unit can withstand temperatures to 350 F. Pressure ratings: 750 or 1500 psi.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*
For more information circle **224** on inquiry card.

Liquid Level Controller

New "Type 1450 Pilot" is for liquid level control where a torsion tube transmits displacement-element move-



ments to reflect changes in liquid level or a change in gravity of controlled fluid. Features: (1) wide (100-percent) throttling range; (2) specific gravity index compensating for various gravities of liquids (or for interface services) where throttling range is kept exact in its relationship to the specific gravity setting; (3) change to on-off action without special parts.—*Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 3, Mo.*
For more information circle **225** on inquiry card.

Liquid-level Controller

New magnetic liquid level control system has probe operating on conductivity principle; is designed for liquid temperatures to 600 F., pressures to 500 psi. and ambient temperature range of zero to 150 F. Stainless steel probe is only part immersed; no electrolysis since maximum current passing through liquid is 5 milliamperes a.c. Instrument will operate in

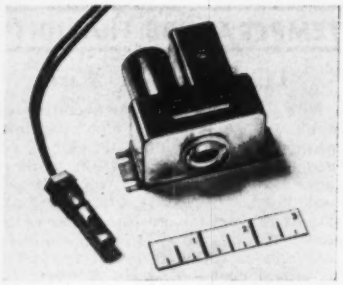
any position, therefore ½-in. mounting hole may be located on any wall of tank boiler, etc. Weather-proof, water-tight and explosion-proof models are available.—*Viking Instruments, Inc., East Haddam, Conn.*
For more information circle **226** on inquiry card.

Liquid-level Controller

New "Level Control Type 13DJ3" said to be "the most universal and efficient level control available to industry," controls level of all electrically-conductive liquids; comprises an electron tube amplifier and heavy-duty relay which may be wired for double-break operation to carry up to 20 amps. non-inductive at 230 v.ac.—*Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.*
For more information circle **227** on inquiry card.

Liquid-level Controller

New "Liquid Sensing Control" detects presence of liquid in less than one second when probe is immersed by 0.025 in. or more; then detects absence of liquid in less than 3 sec. Components: thermistor-type probe,

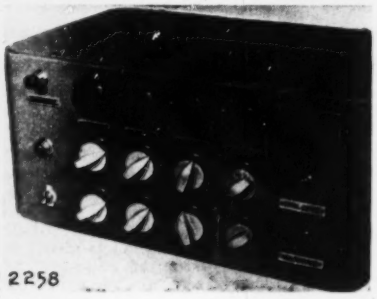


connecting cable, and "Power Control Unit" which contains control relay (either 110 v.ac. or 28 v.dc.). Probes and control units available in multiple assemblies for plural levels or points of liquid detection.—*Control Instrument Div., McDermott Water Heaters, Inc., 514 Genesee St., Trenton 10, N. J.*
For more information circle **228** on inquiry card.

TIME and COUNT

Electronic Preset Counter

New "Quadruple Preset Decitron" is capable of absolutely accurate counting of objects as small as 0.04 in. with spacing between units as small as ⅛ in. regardless of conveyor speed, at speed up to 6000 units per second. Permits totalizing counts in



NEW!

Ohmite compounded, special resin encloses all parts. Its coefficient of expansion closely matches that of bobbin, wire, and terminals.

Rigid steatite bobbin keeps pie windings in place.

Resistance wire welded to terminals insures perfect connections.

Bobbin is completely encapsulated—ends and even center hole.

OHMITE®

Proudly announces the

RITEOHM®

***completely* encapsulated**

precision resistor

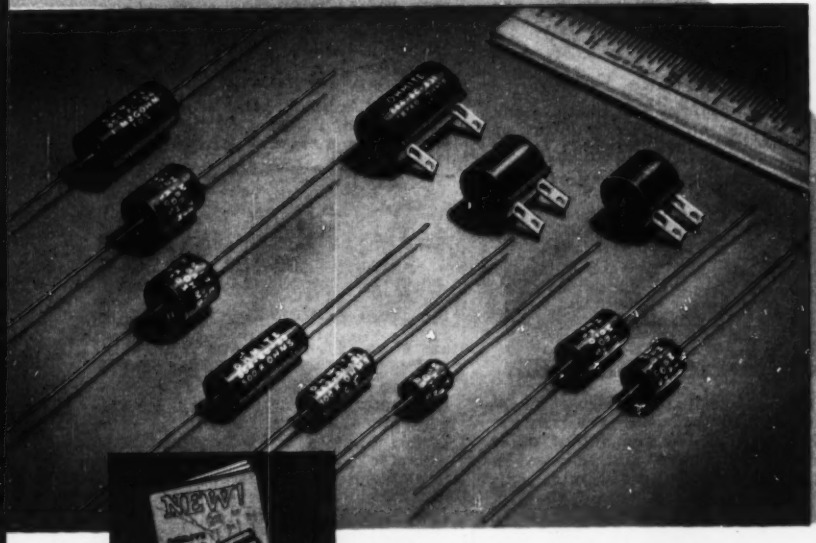
type 85 and 86

Exceeds

MIL-R-93A

Amendment 2

at 125 C ambient



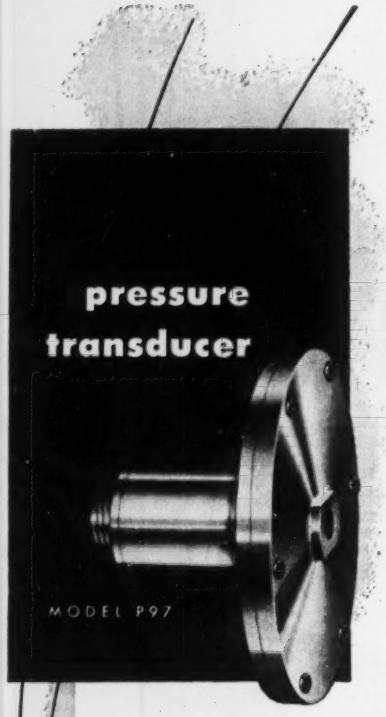
Now . . . a new Ohmite encapsulated, wire-wound, precision resistor, designed to provide absolute stability. Winding is protected against moisture or mechanical damage by a rigid steatite bobbin encapsulated in Ohmite-compounded, special resin. Resistance wire is welded to terminals. Axial-lead and lug types, in sizes from ¼ to 1 watt (125° C ambient) in a wide range of resistance values. Tolerances to ± 0.1%.

Write for New Descriptive Bulletin

Be Right with **OHMITE** **RHEOSTATS RESISTORS TAP SWITCHES**

OHMITE MANUFACTURING COMPANY, 3615 Howard Street, Skokie, Illinois (Suburb of Chicago)

For more information circle **33** on inquiry card.



Differential or gage pressures in the range 0-0.05 psi are measured accurately and simply with the Model P97 pressure transducer.

The output of this instrument is 3.5 millivolts per volt full scale, permitting direct operation of a wide variety of commercially available recording, indicating, or controlling devices.

Pressure applied to the instrument is translated into an exact electrical equivalent by means of a full bridge transducer based on the unbonded strain wire principle.

Please request Bulletin No. 3.5.

S&L Statham LABORATORIES • Los Angeles 64, Calif.

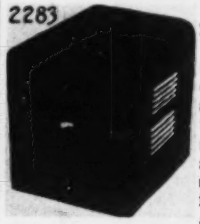
For more information circle **34** on inquiry card.

NEW INSTRUMENTS

any quantity from one to and including one million. Counts by dozens, hundreds, gross lots or any other combination. Negligible maintenance. —*Dep't P3, Post Machinery Co., 150 Elliott St., Beverly, Mass.*

For more information circle **229** on inquiry card.

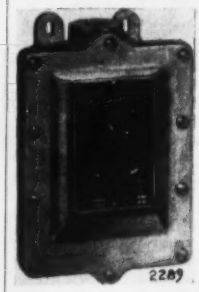
Welding Timer



New "Model F-216 Fractional Cycle Timer" meets special requirements of resistance welding: timing spot or seam welders; also other timing operations requiring extreme reliability. Among features: positive adjustment in fractional-cycle range; all controls accessible from front panel; cathode-protection circuit. Standard unit has 40-amp. peak output.—*Vacuum Tube Products, 506 S. Cleveland St., Oceanside, Calif.*

For more information circle **230** on inquiry card.

Explosion-proof Timers



New explosion-proof case has been developed for maker's electric timers. Setting knob of timer is directly connected to switch operating cam: positive switch action. All energy required to operate switch is built up by manually setting pointer, relieving motor and clutch of all drag. Switch is s-p.d-t., 1000-watt, fully enclosed. Self-starting synchronous slow-speed motor is completely sealed.—*Dep't IXP, Zenith Electric Co., 152 W. Walton St., Chicago 10, Ill.*

For more information circle **231** on inquiry card.

10-Mc. Decade Scaler

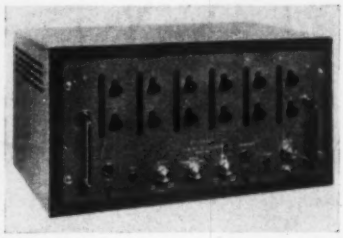
New "Epic Model 412 Fast Decade Scaler" is for high-speed counting of fast pulses, h-f. measurements (to 10

Mc.) and small time-interval measurements (to 0.1 usec. accuracy). Scale factor of 100 and output pulse characteristics have been chosen so that almost all slow commercial scalers (approx. 10^5 counts/sec.) and frequency counting equipment, can be operated from output pulse with ease. —*Electrical and Physical Instrument Corp., 25 W. 43rd St., New York 36, N. Y.*

For more information circle **232** on inquiry card.

Dual Preset-count Controller

New "Series 5440" Dual Preset Counter" provides output signals at any two counts (within maximum ca-



pacity of 999,999) from photocells, magnetic pickups, switches, etc., at rates up to 40,000 times per second. Output signals can be used to control processes automatically.—*Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.*

For more information circle **233** on inquiry card.

COMPUTING

Electronic Computer

New "E101 Electronic Computer," contained in a desk-size cabinet, is said to "bring electronic computing techniques within the reach of a much wider range of users." It has an internal memory unit of magnetic drum type used in maker's "UDEC" and other large electronic computers.—*Burroughs Corp., Detroit 32, Mich.*

For more information circle **234** on inquiry card.

Adding Machine With Code-tape Output

New "Add-Punch" business machine eliminates repetitious handling of routine office accounting tasks; it produces a standard adding-machine tape and simultaneously enters data on a ¾-in. code tape similar to that now used by communication services.—*Friden Calculating Machine Co., Inc., 2350 Washington Avenue, San Leandro, Calif.*

For more information circle **235** on inquiry card.

Digitizer

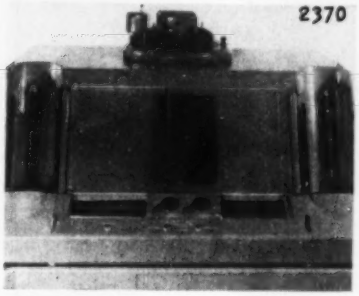
New "Analog-digital Converter" simplifies and speeds up digitizing by eliminating ambiguity and intermedi-

ate steps. Signal travels from shaft position to code disks and thence to either a relay system or a diode-scanning network followed by a single flip-flop. Time sharing for multi-channel systems allows control circuit to be used for scanning many digitizers. Standard code disks binary; Gray, decimal or other systems to order. Present models include 7-, 13-, 17- and 19-digit units. Conversion from digital code to shaft rotation can be made.—*Librascope, Inc., 1607 Flower St., Glendale, Calif.*

For more information circle **236** on inquiry card.

Data Analyzer-reader

New "Oscar F" electronic data reduction machine permits rapid semi-automatic reading of both oscillographic and film records. With it



and an accompanying digitizer, user can quickly read and calibrate records and supply data automatically to a computer and an electric typewriter. Arithmetic and algebraic corrections applied graphically.—*Benson-Lehner Corp., 2340 Sawtells Blvd., Los Angeles, Calif.*

For more information circle **237** on inquiry card.

Computers

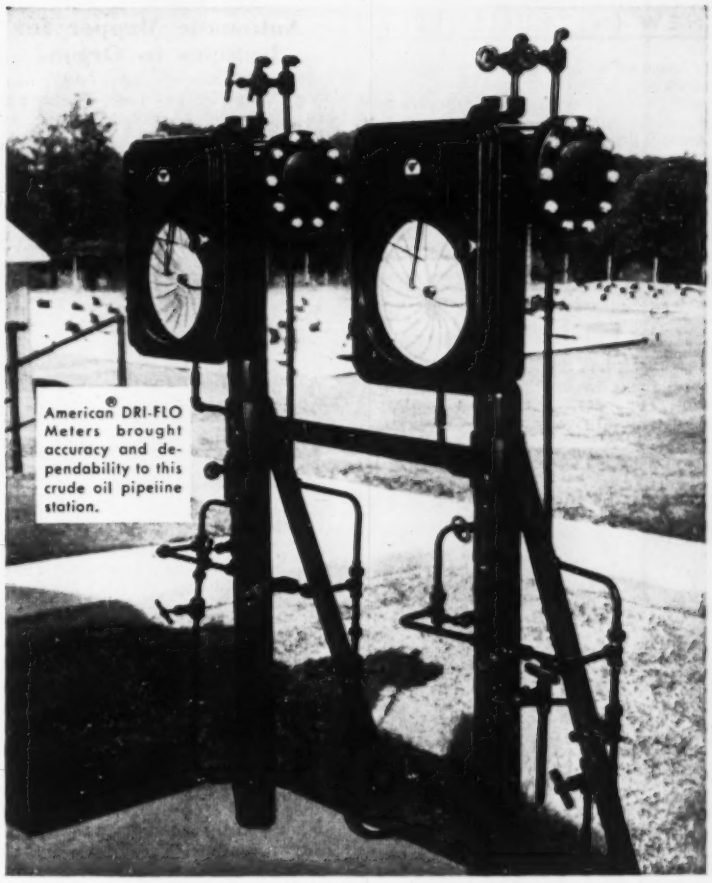
New "Loromark" and "Seac" are high-speed portable desk-side analog computers for design and analysis of

physical systems. New "Tridascope" is an electronic and electromechanical plotting board for three-dimensional stereoptic perception of three-dimensional trajectories.—*Mark Instrument Co., Inc., 613 Wilshire Blvd., Santa Monica, Calif.*

For more information circle **238** on inquiry card.

Digitizer

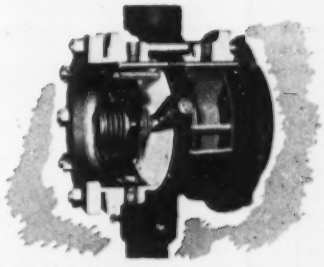
New "Digi-Coder" converts continuous-series output of primary elements such as thermocouples or pressure pickups into a digital signal for elec-



Do you have a tough metering problem?

Installed at Mid-Continent Pipe Line Company's booster station at Seminole, Oklahoma, these two American DRI-FLO Meters measure high pressure (900 PSI) crude oil in the pipelines to the Company's Tulsa Refinery.

Meter accuracy and dependability are completely satisfactory despite constant vibration and the "tough" nature of the job. No seal pots are required, eliminating "blown" seals and emulsified mercury. Because of the close proximity (70 feet) to the discharge of the booster pumps, the meter pipestands are mounted in a concrete platform and are specially braced. Meter indications, read from the office window, help dispatchers quickly locate troubles such as line breaks, pump or valve failures—and eliminate running high pressure oil lines to the dispatchers office.



DRI-FLO Meters bring American-Westcott precision, simplicity of installation and maintenance, with maximum resistance to corrosive material, to applications where mercury manometers are not desired. Differential ranges: 20", 50", 100" and 200"; working pressures to 1000 PSI; Ambient temperatures of −25° to 175°F.

Write for full information

AMERICAN METER COMPANY

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
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IN CANADA: Canadian Meter Company, Limited, Hamilton
Edmonton • Calgary

For more information circle **35** on inquiry card.

tric typewriters, digital computers, punch card equipment, etc. Two basic types: One converts a mechanical motion; other contains an integral self-balancing potentiometer, converts voltage; various models within these two basic types.—*Data Reduction and Automation Div., Fischer & Porter Co., 22 Jacksonville Rd., Hatboro, Pa.*

For more information circle **239** on inquiry card.

NUCLEONICS

Alpha Particle Detector

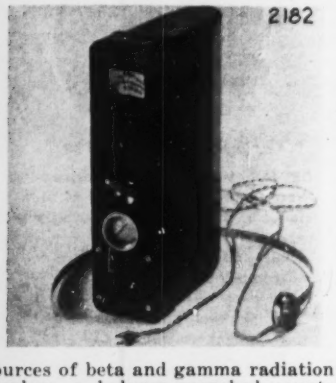
New "Alpha Scintillation Poppy" is insensitive to beta and gamma radiation; operates with most scalers and rate-meters; comprises (1) phos-

phor screen; (2) electron-multiplier phototube; (3) preamplifier which sends pulse to a scaler circuit, and (4) shell which acts as mounting for components and keeps light from phototube. Weight 38 oz.; screen sensitive area of 150 sq. cm.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **240** on inquiry card.

Beta and Gamma Detector

New "PW 4010" radiation detector is approx. 1.7x4.1x6.6 in.; weighs about 25 oz.; is designed for locating

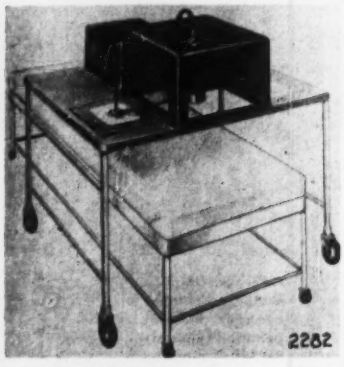


sources of beta and gamma radiation; employs a halogen-quenched counter tube and a diode-pentode oscillator tube. In addition to built-in intensity meter, a single midget earphone with headband, cord and plug is available. —*Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.*

For more information circle **241** on inquiry card.

Automatic Mapper for Isotopes in Organs

New "Tracer-Scanner" for scanning body areas and producing a graph of isotope concentration (e.g.



showing iodine-131 distribution in thyroid gland) covers 15x15-in. area, has adjustable traverse speed and adjustable interscan spacing.—*Tracerlab Inc., 130 High St., Boston 10, Mass.*

For more information circle **242** on inquiry card.

Scintillation Crystals

New cylindrical anthracene and stilbane crystals with thicknesses from ½ in. to 5 in. and diameters from 2 in. to 3½ in. have highly-polished parallel faces, are particularly suitable for scintillation counter work. Pulse height comparison between maker's anthracene crystals and Oak Ridge standard is unity.—*Wakefield Industries, Inc., 5108 West Grove St., Skokie, Illinois.*

For more information circle **243** on inquiry card.

LABORATORY

Pipette Control

New "Micropet" eliminates mouth pipetting; prevents accidental imbibing of toxic or infectious liquids. To use: pipette is slipped into *ad hoc* opening; fluid is drawn into pipette by collapsing and releasing rubber bulb; fluid is dispensed by depressing release plunger. A delayed action mechanism in plunger permits technician to control discharge rate. Aliquots may be dispensed with an accuracy of 0.01 milliliter.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

For more information circle **244** on inquiry card.

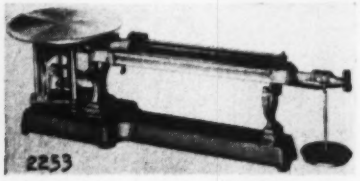
Centrifuges

New electric centrifuges meet requirements of ASTM D96 test for "Bottom Sediment and Water in Petroleum Products." Among features: Ball-bearing life-time lubricated motor; Ohmite speed control rheostats; gyroscopic stability.—*Labline Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **245** on inquiry card.

Solution Balance

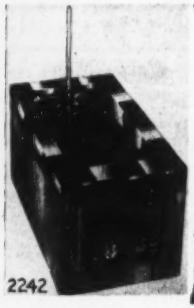
New "Heavy Duty Solution Balance" has been redesigned. Among new features: graduated end reading



dial enables obtaining balancing position in seconds and eliminates parallax; aluminum alloy beam enhances sensitivity and prolongs life of balance; 11-in. weighing platform is stainless steel, as are relief etched beams.—*Ohaus Scale Corp., 1050 Commerce Ave., Union, N. J.*

For more information circle **246** on inquiry card.

Constant-temperature Baths

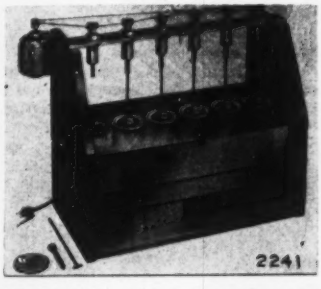


New constant-temperature baths for serological work utilize thermo-wall construction. Thermoregulators are hydraulic type, with sealed contacts, special calibrations for 37 and 56 C. Temperature accuracy 0.25 C. Ten different types include 2-compartment type for incubation and inactivation at 37 and 56 C.—*Chicago Surgical and Electrical Co., 217 N. Desplains St., Chicago 6, Ill.*

For more information circle **247** on inquiry card.

Six-spindle Stirrer

New multiple stirrer, featuring six spindles and constant-temperature bath, was originally developed to run



ASTM D-665 turbine oil rusting tests; can be used wherever solutions must be stirred at constant speed and temperature.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **248** on inquiry card.

Colorimeters

Two new tristimulus colorimeters have been developed primarily for measurements of TV picture tubes for chromaticity (CIE x and y) and brightness in accordance with new procedure of Joint Electron Tube Engineering Council. However, they can both be used for color by reflection and

measure oxygen direct

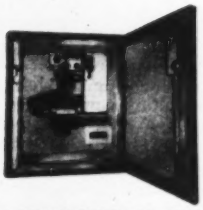
paramagnetic method of measurement extremely accurate in analyzing industrial gases

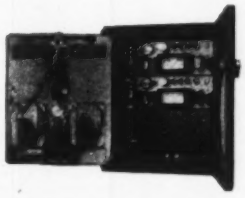
Oxygen is unique among other common gases in that it is highly paramagnetic (attracted into a magnetic field). This property of oxygen is the basis of the operation of the Hays Magno-Therm Analyzer in the analysis of industrial gases.

application

Hundreds of companies are using the Hays Magno-Therm O_2 Analyzer and Recorder in applications from revivification of SO_2 removers in manufactured gas industry and regeneration of catalysts in oil refineries to mixing air with propane to get substitute fuel. Boiler plants use it as a combustion guide because it is the only means of getting an undistorted picture of excess air.

Write today for bulletin 52-829-56 and get complete details.





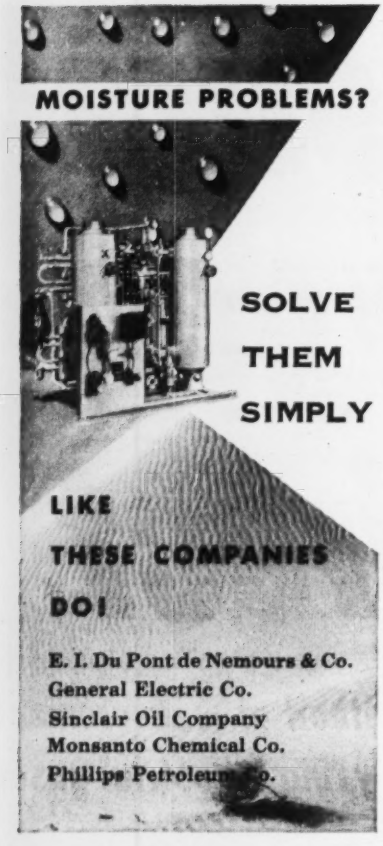
ANALYZER	RECORDER
Highly sensitive to changes in oxygen content.	Self-balancing bridge circuit assures accurate, permanent calibration.
Rapid response to changes in oxygen content.	Electronic amplifier has no moving parts. High sensitivity. Rugged.
No liquid or gaseous fuel required to be added to gas sample.	Immediate response—analyzer is continuously connected to recording pen drive motor.
No chemicals required.	As many as four analyses can be recorded on the same chart.
High accuracy maintained.	Range can be changed easily in the field.
Not affected by wide variation in rate of flow of gas sample.	Isolating transformer for each amplifier removes line interference from bridge circuit.
Rugged construction. No delicate or moving parts.	Extra slide wire available for control, remote indication—for recorder or contacts for alarm circuit.
Easily installed — no special fittings required.	

Automatic Combustion Control Boiler Panels • CO_2 Recorders Variflow Meters and Veritrol Gas Analyzers • Draft Gages Combustion Test Sets Electronic Oxygen Recorders Electronic Flowmeters Electronic Feed Water Controls Miniature Remote Indicators

THE hays CORPORATION

Michigan City 8, Indiana

For more information circle **36** on inquiry card.



. . . and dozens and dozens more of the country's leading firms, technological schools, the armed services, the U. S. Atomic Energy Commission . . . *all* choose Pritchard HYDRYERS* for efficient, dependable dehydration of compressed air and other gases for instrument and process controls.

Standard packaged units reduce dew points to minus 40°F...custom units for extreme conditions or special requirements.

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COOLING TOWERS • SPECIALIZED HEAT EXCHANGERS • GAS & AIR TREATING EQUIPMENT

For more information circle **37** on inquiry card.

NEW INSTRUMENTS

transmission as well as by phosphor emission. Insertion of a daylight filter permits measurement of objects as under daylight. Use of an ultraviolet source permits measurement of phosphor colors under u-v. rather than electron-beam excitation. "Model D12A" has a disk with tristimulus filters in front of a photocell. "Model D12B has three photocells, each with its own filter.—*Hunter Associates Laboratory, 5421 Brier Ridge Rd., Falls Church, Va.*

For more information circle **249** on inquiry card.

Monochromator

New "Model H. Monochromator" incorporates five quartz sections (instead of four used in "Model B").

Pass band width is narrower: 40 to 120 A. Quartz sections vary in length from 4 in. to ¼ in. Unit (without light source) is 10¼ in. long; features 1-in. circular aperture instead of slit.★ New light source has been specially adapted for "Model H" and "Model B" monochromators; is easily attached; becomes part of unit.—*Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.*

For more information circle **250** on inquiry card.

Distillation Apparatus

New "Dalin Distillation Apparatus" for laboratories and pilot plants permits charges from 2 ml. to 72 liters to be easily fractionated. Standard columns can be supplied with boil-up rates up to 30 lph., depending upon diameter of column and packing. New columns are adiabatic, are heated by coiled-ribbon windings for operating at temperatures up to 350 C. Differential thermocouples are supplemented by thermometers located in each winding to indicate column temperature during preheating stage, before vapor rises into the column; column can thereby be brought to desired operating temperature while charge is being raised to boiling point.—*Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.*

For more information circle **251** on inquiry card.

DIMENSIONAL

Coating-thickness Gage

New "Pocket Handi - Gage" is similar in size and shape to an automobile tire gage. When its magnetic end is applied vertically to surface to be tested and slowly pulled away, a calibrated inner stem appears. Distance of stem travel before magnet releases itself from surface is a measure of thickness of non-magnetic coating on steel. Thickness range, 0.0001 in. to 0.015 in.—*Platers Research Corp., 59 East Fourth St., New York 3, N. Y.*

For more information circle **252** on inquiry card.

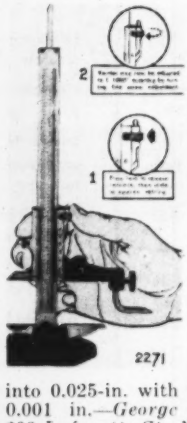
Coating-thickness Gage

New "Elcometer" measures thickness of non-magnetic protective and decorative coatings on ferrous metal bases; is English-made; has accuracy

of 5 percent plus or minus 0.0001 in.; incorporates a locking device for reading scale after measuring an inaccessible area where scale cannot be seen. —*Dept. TFM, Ferro Corp., 4150 E. 56th St., Cleveland 5, Ohio.*

For more information circle **253** on inquiry card.

Caliper and Height Gage



New "Mauser Microlock" 6-in. combination vernier caliper and height gage features new design. Omitting commonly-used separate fine-adjustment slide results in approx. 1 in. increase of measuring capacity. Upper scale of vernier is graduated into fractions of an inch with 1/128-in. vernier; lower scale is divided into 0.025-in. with vernier reading of 0.001 in.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **254** on inquiry card.

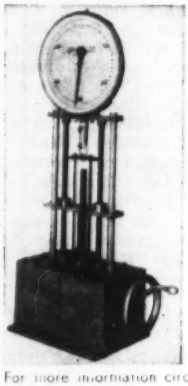
Continuous Thickness or Density Beta Gage

New "Model S" of maker's "Accu-Ray" beta gage features an electrically-operated power supply, stabilized feedback electronic amplifier, shock mountings for critical components, locked-in source with provision for alarm system, standardization for span sensitivity and extra-strong industrial construction. U-shaped source detector unit is patterned after maker's original design. It permits measuring sheets up to 24 in. wide.—*Industrial Nucleonics Corp.*, 1205 *Chesapeake Ave., Columbus* 12, *Ohio.*

For more information circle **255** on inquiry card.

TESTING

Spring Tester



New "Model 965" tests compression springs up to 4½ in. diam. by 12 in. long and extension springs 4½ in. diam. by 10 in. long. Basic stand; interchangeable heads in capacities from 10 to 600 lbs.—*John Chatillon & Sons*, 85 *Cliff St., New York* 38, *N. Y.*

For more information circle **256** on inquiry card.

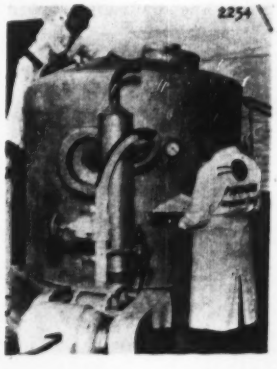
Base and Socket Tester

New "Grip" Tester uses special interchangeable gages simulating vacuum-tube bases and/or sockets to provide rapid reading of insertion or extraction forces required of male and female tube sockets. Range 0-100 lbs.—*Size Control Co.*, 2500 *W. Washington, Blvd., Chicago* 12, *Ill.*

For more information circle **257** on inquiry card.

Aviation-type Test-chamber

New environmental test chamber reproduces weather and altitude hazards encountered by high-flying jet planes; was developed to test maker's ejection gun (for ejection of jettisonable fuel tanks and other external stores at any airplane speed or flight attitude). Design and construction allow for explosive ejection tests of steel beams, bombs etc. under any required



NEW

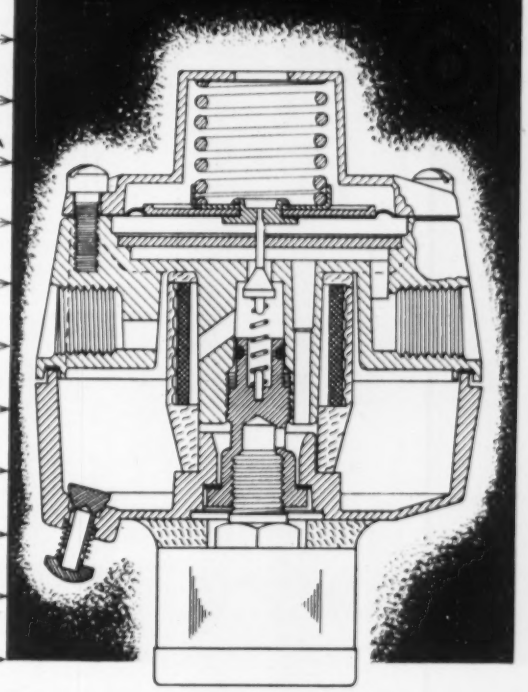
KENDALL
FIXED-OUTPUT
REGULATOR

Designed Especially for Instrument Air Supply Service

Kendall's New Model 50 is ideal for flow up to 10CFM or dead-end service because of its sturdy, tamper-proof construction combined with the filter-dripwell feature and drift-free characteristics.

FEATURES AND ADVANTAGES

- SMALL SIZE: 4⅛" HIGH x 3⅜" DIAMETER
- RUGGED CONSTRUCTION: BUILT TO LAST
- LARGE FREE FILTER AREA: 35 x STANDARD ¼" PIPE AREA
- HIGH DRIPWELL CAPACITY: NO FILTER INTERFERENCE
- CAN BE SUPPLIED WITH PRESSURE GAUGE
- VENTURI ASPIRATION
- 150 LB. SUPPLY PRESSURE
- STAINLESS STEEL VALVE SPRING
- SELF-CONTAINED SAFETY RELIEF VALVE
- PUSHBUTTON DRAIN VALVE
- COMPETITIVELY PRICED



ADJUSTABLE MODEL 55
For use where frequent adjustment of output pressure is required. Can be either panel or pipe mounted. Equipped with bronze threaded bushing for hex head adjustment screw or handwheel screw. Available in ranges from 2 to 100 p.s.i.

FOOLPROOF BECAUSE IT'S TAMPERPROOF

Investigate Kendall's new fixed output regulator today. Send for further technical information. Outline your requirements and ask for prices.

"Engineered Air Regulation"

KENDALL CONTROLS CORP.
144 MOODY ST., WALTHAM 54, MASS.

For more information circle **38** on inquiry card.

BARBER COLMAN

ultra-sensitive relays

on Calidyne Shaker control for accurate regulating of amplitude and acceleration

Product of The Calidyne Company, Winchester, Mass., the Calidyne Shaker with console as shown above is used for vibration-testing of industrial, military and commercial products.

It provides vibration frequencies up to 2000 cycles per second and has a 600 lb. vector force output. Another model features 1250 lb. force output. Amplitude and acceleration of the shaker is automatically regulated with a servo control unit which employs a Barber-Colman "Micropositioner" to compare shaker response voltage against a base voltage and correct the circuit accordingly.

Ideal for hundreds of other industrial applications, Barber-Colman Company's d-c polarized relays are ultra-sensitive and stable. High-speed response. Available in a wide range of coils, enclosures and mounting details.

Write today for Bulletin F3961-2

BARBER-COLMAN COMPANY
Dept. G, 1415 Rock Street, Rockford, Illinois

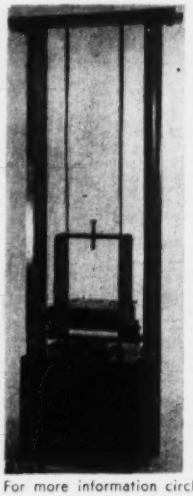
For more information circle **39** on inquiry card.

NEW INSTRUMENTS

atmospheric condition. Altitudes to 60,000 feet; temperatures from –100 F. to 200 F. controlled to 2 F. Vacuum pumps can be reversed to provide positive pressures. Carbon dioxide can be transferred into chamber (see photo). Humidity can be simulated.—*Pastushin Aviation Corp., 6901 Melrose Ave., Los Angeles 38, Calif.*

For more information circle **258** on inquiry card.

Shock Test Machine

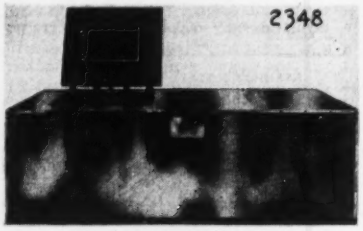


New "Shock Testing Apparatus" subjects components and small assemblies (weighing up to 4 lbs.) to preselected and reproducible shock loads up to 120 G; can be mounted on any solid bench. No adjustment or resetting for successive drops. Constructed and calibrated in conformance with MIL-STD-202.—*Anthony Mfg. Co., Inc., 407-409 Main St., East Orange, N. J.*

For more information circle **259** on inquiry card.

Components-testing Cabinet

New "W-9-100 FH Test Unit," designed primarily for testing electrical components has temperature range from –100 F. to 200 F. New type door

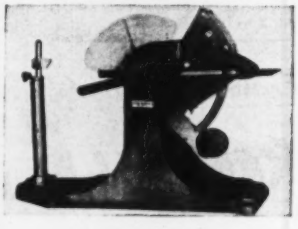


has removable "plug" panel with forty ¼-in. openings for test leads. Heat cycle is applied through Calrod type heating elements. Inside dimensions of test chamber 10 in. wide, 32 in. long, 26 in. deep.—*Dep't R-199, Webber Mfg. Co., Inc., 2740 Madison Ave., Indianapolis 3, Ind.*

For more information circle **260** on inquiry card.

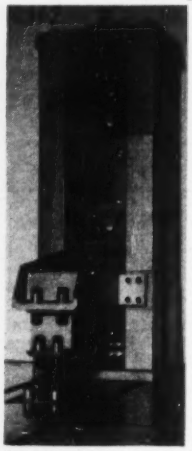
Puncture Tester

New "TMI-Beach Puncture Tester" is based on an original G-E design, conforms to ASTM D781-44T. Corrugated board, vulcanized fibre, wall board, plywood, etc., can be tested rapidly by factory personnel or lab technicians. Range for corrugated and fibre board up to 0.140 in.—*Testing Machines, Inc., 123 W. 64th St., New York 23, N. Y.*



For more information circle **261** on inquiry card.

Fatigue-test Capacity Multiplier

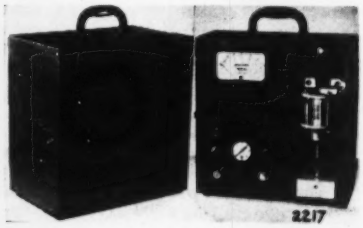


New "Sonntag Five-to-One" multiplying fixture makes possible fatigue tests under loads up to 50,000 lbs. on a 10,000-lb. capacity fatigue machine. Maximum specimen deflection is plus and minus 0.05 in. A flex-plate acts as fixed pivot of a 30-in. lever which is vibrated vertically by oscillator of fatigue machine.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **262** on inquiry card.

Weld-surface Tester

New "Surface Resistance Analyzer" measures aluminum interfacial sheet-to-sheet resistance in connection with

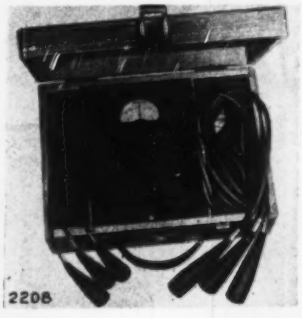


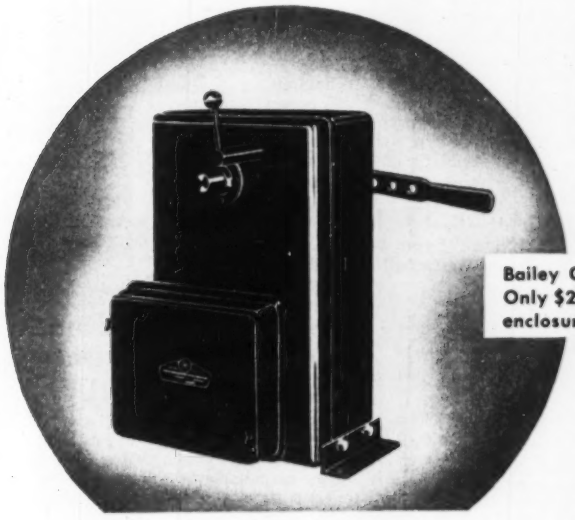
resistance welding; weighs 30 lbs. All operating components, microhmmeter and sample holder, are contained in one unit. No special skill is required for operation.—*Chemical Research Associates, 333 N. Michigan Ave., Chicago 1, Ill.*

For more information circle **263** on inquiry card.

Rotation and Phase Tester

New "Motor Rotation and Phase Tester" is said to be the first device for determining direction of rotation of electric motors before they are connected to line and also for deter-





Bailey Control Drive, Type AC44P Model 200. Only $210.00 F.O.B. Cleveland, complete with enclosure, positioning relay and hand operator.

Want Better Flow Characteristics from Your Regulating Devices?

This new, small, piston-operated Bailey Control Drive will improve the flow characteristics of butterfly valves, dampers, hydraulic couplings, feeders and similar regulating devices. Adjustment is simple; any desired relation between drive motion and pneumatic signal may be secured.

You can install this compact pneumatic drive power unit in any position on a column, pipe, or flat surface—and connect it to the regulating device with standard Bailey linkage, available from stock.

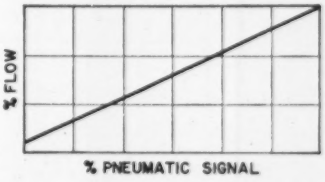
Speed (time required for full travel) is adjustable to suit your requirements. Bailey Control Drives operate on standard SAMA pneumatic signal ranges of 3 - 15 or 3 - 27 psig.

AVAILABLE FROM STOCK in 3 standard sizes

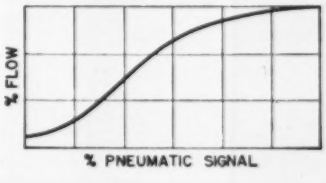
Type	Piston Dia. Inches	Piston Stroke Inches	Torque ft-lb	Max. Travel Degrees	Approx. Dimensions Inches
AC816	8	16	1500	90	13 x 27 x 51
AC68	6	8	400	90	13 x 19 x 34
AC44	4	4	75	75	10 x 11 x 19

P-2R

The New Bailey Control Drive gives you THIS—



instead of THIS



BAILEY METER COMPANY

1041 IVANHOE ROAD

CLEVELAND 10, OHIO

Complete Controls for Process Plants

BAILEY METERS

Controls for

TEMPERATURE
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GAS ANALYSIS
FLOW LEVEL
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☐ I am interested in Bailey Control Drives. Mail me Spec. CA040.

☐ I am interested in Bailey Control Linkage. Mail me Spec. CA942B.

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City & Zone _____ State _____

For more information circle **40** on inquiry card.

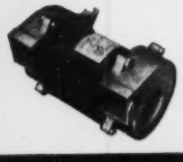
15 Horse Power in a 7"x 11" case!

A typical example of American Electric engineering

This 400 cycle 3 phase motor is a special custom-developed aircraft design. Rated at 15 h.p. continuous duty at 11,500 r.p.m., it actually produces 19 h.p. on intermittent duty, yet occupies less than ¼ cubic foot. Weight is 32 lbs.—approximately ½ h.p. per lb. Fungus-proof, corrosion resistant, meets AND 20002 type XIIB mounting specifications. Temperature range: −67° to +131° F. Motor length: 7", Coupling extension 4".

MINIATURE MOTORS for all PURPOSES!

American Electric Motors are also built in an almost unlimited range of miniatures for 60 and 400 cycle operation as well as variable frequencies. All feature low weight, compact size and meet high temperature requirements. Supplied in induction or synchronous types for motor drives, propeller fans and centrifugal blowers. Wire, write or phone for data and quotations.



Also Manufacturers of High Cycle Motor-Alternators and A.C. Industrial Motors.

AMERICAN ELECTRIC MOTORS

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JOE DAVIDSON & ASSOCIATES, Los Angeles

For more information circle **41** on inquiry card.

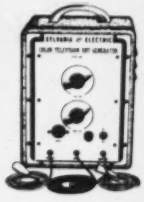
NEW INSTRUMENTS

mining phase rotation or sequence of energized power circuits. Other uses: determine polarity of power and instrument transformers, and as a continuity tester.—*James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.*

For more information circle **264** on inquiry card.

Color TV Dot Generator

New "Type 506 Color Television Dot Generator" provides a pattern whereby the beams of a color cathode-ray tube, of 3-gun type, may be properly converged by serviceman. Sync is coupled directly from receiver. Wide range of dot spacing is provided for convergence and linearity adjustments. Positive gating and triggered multivibrators assure undistorted output. Test leads permanently fasten to front panel.—*Radio and Television Div., Sylvania Electric Products Inc., 254 Rano St., Buffalo 7, N. Y.*



For more information circle **265** on inquiry card.

Dot-bar Generator

New "WR-36A" is said to be the first dot-bar generator designed specifically for making all convergence adjustments in TV color receiver.—*Tube Div., Radio Corporation of America, Harrison, N. J.*

For more information circle **266** on inquiry card.

Color-bar Generator

New "WR-61A" is said to be TV industry's first service-type color-bar generator which produces on a receiver screen a multiple-color test pattern of ten color bars for adjusting color phasing and matrixing circuits.—*Tube Div., Radio Corporation of America, Harrison, N. J.*

For more information circle **267** on inquiry card.

Dual-band-width CRO

New "WO-78A" five-inch dual-band-width oscilloscope has been developed for observing color-burst signal and checking operation of color-burst circuit in TV receivers with screen having some 200,000 triangular clusters of red-blue-green phosphor dots.—*Tube Div., Radio Corporation of America, Harrison, N. J.*

For more information circle **268** on inquiry card.

Test Socket Adapters

New 7- and 9-pin miniature test socket adapters, and 8-pin octal test socket adapter, for making measurements from top of chassis while set is operating, feature extended test tabs, low RF loss. Available at leading jobbers.—*Pomona Electronics Company, 524 West Fifth Avenue, Pomona, Calif.*

For more information circle **269** on inquiry card.

Flyback and Yoke Tester

New "Model 994 Flyback Transformer & Yoke Tester," available in kit and wired instrument form, operates on grid-dip principle, detects one shorted turn. Feature is separate calibration for air core and iron core flybacks.—*Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **270** on inquiry card.

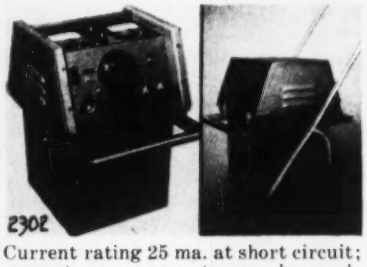
UHF Marker-generator

New "Ultra-Marker" provides crystal-controlled narrow pip type markers at picture and sound carrier frequencies on all UHF channels (by switching, on every fourth UHF channel starting with Channel 15). Maximum frequency error, 200 kc.; error at center of band, 0.007 percent. Input requirement, 10 mv. across 70 ohms from any sweeping oscillator covering frequency range.—*Kay Electric Co., Pine Brook, N. J.*

For more information circle **271** on inquiry card.

Dielectric Test Set

New "Model 1—40kv Dielectric Test Set" is a mobile field instrument which measures d.c. at voltages up to 40 kv.



Current rating 25 ma. at short circuit; current measurements can be made down to 0.5 microamps. All high-voltage components oil-immersed.—*James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.*

For more information circle **272** on inquiry card.

Watthour-meter Tester

New "Type TE-7 Knopp Watthour-Meter-Testing Equipment" is designed for testing single-phase and polyphase watthour meters of all types within test voltages of 120, 240, and 480, and current ranges of 0.25

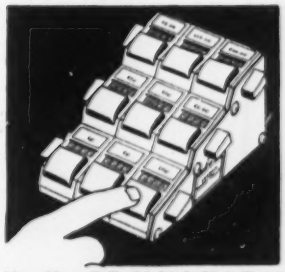
Here's a Fast, Smooth Operator

on many different jobs

Added Evidence that...

Everyone Can Count on VEEDER-ROOT

This new, high-speed direct-drive counter . . . with its one-piece "show window" case . . . was first developed for use in navigational and directional instruments. Then, because of its many adaptable features, it is eligible for employment in many other jobs. It's good for speeds up to 1800 rpm . . . temperatures from 67° to 185° F . . . and it's corrosion resistant. Drive shafts can be longer on either side or both. And base may be lengthened to take more figure-wheels if you want. All in all, a remarkably versatile performer . . . one of scores of standard and special Veeder-Root Counters for every mechanical and electrical application from Electronics to Automation. Write:



New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide. Write for news sheet and prices.

VEEDER-ROOT INCORPORATED • HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada
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® **"The Name that Counts"**

For more information circle **42** on inquiry card.

More Accurate Level Reading of LOW TEMPERATURE LIQUIDS . . .

JERGUSON

Large Chamber

NON-FROSTING* GAGES

YOU get the highest possible accuracy of reading on low temperature, low boiling point liquids with the patented Jerguson Non-Frosting Gage in the New Large Chamber model . . . because it insures less turbulence at the meniscus, and clear vision at the vision slot.

This new Jerguson model has 6 times larger area at the meniscus than the standard gage, so that there is a marked reduction in turbulence with light gaseous fluids that tend to boil or surge. Moreover, the problem of frosting encountered with these liquids has been eliminated by a patented frost preventing unit extending from the gage glass. This special transparent unit projects beyond the cover bolts and prevents frost from building up over the vision slot.

Here's a dual feature gage that assures greatly increased accuracy of reading for the process industries. If you have a problem with light gaseous fluids, or with gage frosting, it will pay you to investigate the new Jerguson Large Chamber Non-Frosting Gage . . . reflex or transparent.

Jerguson Large Chamber Gage, Transparent Type, with the patented Non-Frosting Gage Glass Extension. Write for literature on this gage, and on other non-frosting Jerguson models.

**Patented*

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

100 Foliisway, Somerville 45, Mass.

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Pétrole Service, Paris, France

For more information circle **43** on inquiry card.

NEW INSTRUMENTS

to 50 amps.; features Knopp Uniload System; includes new switching arrangement, higher insulation test voltage, added capacity in loading transformer, and a constant selector whereby basic constant of rotating standard can be adjusted to match basic constant of meter-under-test.—*Electrical Facilities Inc., 4250 Holden St., Oakland 8, Calif.*

For more information circle **273** on inquiry card.

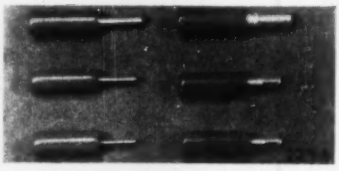
Noise Figure Meter for Transistors, etc.

New "Model NFT Transistor Noise Figure Meter" automatically measures noise figures of transistors, transistor amplifiers, and related devices; eliminates present manual step-by-step procedure; utilizes a calibrated noise source to obtain a continuous direct reading of noise figure. Measurement is independent of gain drifts and band-width changes; is made to I.R.E. standards and is proportional to 1-cps. bandwidth at 1000 cps.—*Electronic Research Associates, Inc., 715 Main St., North Caldwell, N. J.*

For more information circle **274** on inquiry card.

Connector Test Adapters

New "Type 580" kit of "AN" type connector test adapters eliminates damage resulting from use of make-

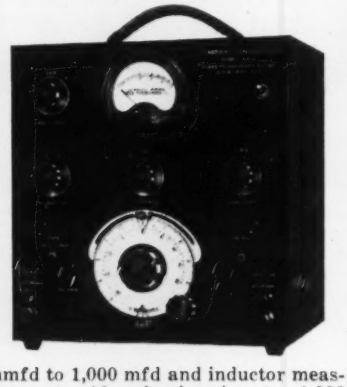


shifts or wrong-size test probes.—*Air-O-Tronics, Box 31, Lancaster, Calif.*

For more information circle **275** on inquiry card.

Resistor, Capacitor and Inductor Tester

New "Type No. 1010A" has 3 test frequencies: 60 cps., 1 kc., 10 kc. Resistor measurements 1 ohm to 10 megohms, capacitor measurements 10



mmfd to 1,000 mfd and inductor measurements 10 microhenries to 1,000 henries. Components adjustable to accuracy of 0.1 percent. Voltage across unknown variable from 0.1 to 10 volts.—*Freed Transformer Co., Inc., 1715 Weirfield St., Brooklyn 27, N. Y.*

For more information circle **276** on inquiry card.

ELECTRICAL INSTRUMENTS

Suppressed-zero Voltmeters

New "Portable Expanded Scale AC Voltmeters" are said to utilize an entirely new principle. Use of movement for top 5 to 10 percent of range permits instruments to obtain high accuracies from a rugged low-accuracy movement. No tubes. Guaranteed accuracy 0.5 percent of input voltage.—*Arga Div., Beckman Instruments, 220 Pasadena Ave., South Pasadena, Calif.*

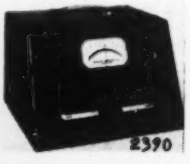
For more information circle **277** on inquiry card.

ULF Millivoltmeter

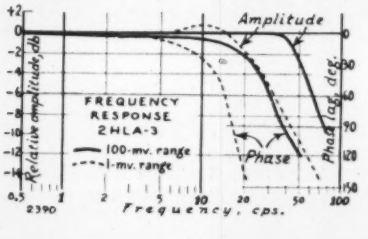
New "Model 316 Infrasonic Voltmeter" for measurement and monitoring of small potentials in ultra-low-frequency systems such as servomechanisms and geophysical equipment. Range: 20 mv. to 200 v. peak-to-peak, directly read in four decade steps throughout spectrum of 0.05 cps. to 30 kc. (Measurements down to 0.01 cps. require corrections.) Discharge of storage circuits for a rapid sequence of readings may be effected by a reset device.—*Ballantine Laboratories, Inc., Boonton, N. J.*

For more information circle **278** on inquiry card.

Ultrasensitive D-c. Indicating Instrument



New "2HLA-3 D-C Indicating Amplifier" can measure 2×10^{-15} watt, thus setting a new record. It is said to "excel all comparable instruments" in its combination of stability, reliability, gain, linearity, accuracy, width of frequency response, immunity to line-voltage and ambient-temperature changes, and adequacy of power to drive a direct-inking recorder. Combination of characteristics results chiefly from use, in input stage, of



Testing with variable A-C Voltage?

THE OLD WAY:

Collect **1.** A variable transformer
2. A voltmeter
3. Connection leads and then connect

THE NEW WAY:
Get all at once in a

VOLTBOX A-C POWER SUPPLY

VOLTBOX TYPE UC1M
PRICE: $53.00

Here's your variable a-c voltage test gear all ready in a compact, cast-aluminum, portable unit that includes:

- **A POWERSTAT variable transformer**
- **A direct reading voltmeter**
- **Three output receptacles**
- **Two Superior 5-WAY binding posts**
- **An "on-off" switch and line-load meter switch**
- **A renewable fuse and 6-foot cord-plug.**

Save your own valuable time and do a better job with a VOLTBOX a-c power supply.

See the Superior Electric's Mobile Display when in your area.

Four types of VOLTBOXES to meet your needs:

Type	Input Volts	Frequency	Output Voltage Range	Output Current (Amps.)
UC1M	120	50/60	0-140	7.5
UC2M	240	50/60	0-280	3.0
U-2000	120	50/60	0-140	20.0
U-2400	240	50/60	0-280	9.0

THE SUPERIOR ELECTRIC COMPANY

707 CLARKE AVENUE, BRISTOL, CONN.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
707 Clarke Ave., Bristol, Conn.
Please send full details on VOLTBOX a-c power supplies.

Name .....
Position .....
Company Name .....
Company Address .....
City ..... Zone ..... State .....

For more information circle **44** on inquiry card.

A Revolutionary New Relay Development

of utmost importance to electrical and electronic design engineers

The Mullenbach Capaswitch uses an entirely new and different concept in relay design to transfer the contacts; provides extreme sensitivity, low power requirements, high current-carrying capacity.

The revolutionary new Capaswitch is basically an ultra-sensitive relay with unusual current carrying capacity. It will perform all of the jobs of conventional magnetic-coil relays, within the same current carrying capacity, plus many jobs that magnetic-coil relays cannot do. However, in design it departs radically from conventional relays. Instead of the usual electromagnetic armature, *a unique electrostrictive capacitive element provides the mechanical energy to open and close the contacts.* Only 0.5 milliwatt-seconds of operating power (150 volts d.c.) is required to close the contacts. To keep them closed requires less than 0.1 milliwatt, or *less than one-hundredth the power required to keep a conventional magnetic-coil relay closed!* This low power requirement opens up a vast new field of applications, eliminating need for much pre-amplified equipment.

How the Capaswitch works—Application of an actuating voltage creates a bending moment in the electrostrictive capacitive element, closing the contacts. Removal of the actuating voltage and discharge of the electrostatic element through external circuits or through a resistor, removes the bending moment, opening the contacts.

Time Delay Function—If appropriate resistances are applied in the circuit, the Capaswitch will function as a time delay relay to open or close the contacts. For longer time delays a larger condenser may be paralleled to the capacitive element.

Pulse Characteristics—Initial closing time of the Capaswitch is 10 milliseconds. However, it can be actuated by pulses as short as 10 microseconds or less. The electrostatic element may also be used to store low power pulses until sufficient voltage has been accumulated to operate the relay. However, present models cannot be used for accurate counting.

Available now—Until recently the Capaswitch has been available only in limited quantities. Now, however, stepped-up production schedules assure increasing supplies.

OVERALL DIMENSIONS:
Length: 3½"
Width: 1-7/16" including solder terminals
Depth: 11/16"
Weight: 1.7 ounces

THE MODEL A-150 CAPASWITCH
a single pole, double throw relay, rated at 1 amp., 110 v., A.C. non-inductive load. Normal operating voltage 150 volts D.C.

Write today for complete specifications and prices!

Mullenbach
ELECTRICAL MANUFACTURING CO.
Established in 1927
2300 East 27th Street • Los Angeles 58, Calif.

For more information circle **45** on inquiry card.

NEW INSTRUMENTS

maker's "Second-harmonic Magnetic Converter" instead of conventional vibrator. Principle of converter is shift of axis of symmetry of a symmetrical non-linear element, enabling d-c. signal flux to aid instantaneous a-c. flux in one core while opposing it in the other. Second stage is a high-gain a-c. amplifier; third stage a demodulator; fourth stage a power amplifier.—*Doelcam Corp.*, 1400 *Soldiers Field Rd., Boston 35, Mass.*

For more information circle **279** on inquiry card.

D-c. Millivoltmeter

New "213-A" is said to be "the first true d-c. millivoltmeter, with high sensitivity, stable zero, and direct polarity indication." Zero center movement with deflection of 1 mv. full-scale; internal noise and drift below 10 uv.; also a d-c. amplifier channel with a maximum gain of 1000, low output resistance, and stable zero and gain. —*Industrial Control Co., Wyandanch, L. I., N. Y.*

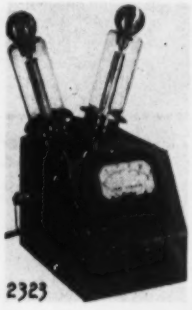
For more information circle **280** on inquiry card.

VTVM

New "Model 442" has total voltage range from 500 microvolts to 500 v. rms. over frequency range of 15 cps. to 250 kc.; includes an amplifier which can be externally used, having a voltage gain of 1,600 (63db). Scale is logarithmic and calibrated from 0.5 to 5.0 for voltage and from −5 to +17 db relative to 1 mw. in 600 ohms. —*Specialty Engineering Div., 79 Clifton Place, Brooklyn 38, N. Y.*

For more information circle **281** on inquiry card.

H-v. Peak-reading VTVM



New "J-1002 High Voltage Vacuum Tube Voltmeter" utilizes two of maker's vacuum capacitor voltage dividers to provide features said to be "not found in any other type of vacuum tube or electrostatic voltmeter." It is peak-reading, with time delay of 0.16 sec. Five ranges include a 50-kv. range in single-ended use and a 100-kv. range in double-ended use. Frequency response flat from 50 cps. to 20 Mc. (to 50 Mc. if derated to half voltage); loading capacity less than 4 uuf. Transient viewing facilitated by CRO connection provided for each divider with a division ratio of 300:1 and a resonant point of 220 Mc.—*Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.*

For more information circle **282** on inquiry card.

VTVM

New "Model 400D" vacuum-tube voltmeter covers all frequencies from 10 cps. to 4 Mc.; measures voltages from 0.1 mv. to 300 v.; is accurate to better than 2 percent up to 1 Mc. Input impedance being 10 megohms, circuits under test are not loaded. New amplifier circuit provides approx. 56 db of feedback in mid-range for stability. Range selecting switch changes sensitivity in accurate 10-db steps. Readings are direct; are always in upper part of scale. New circuit virtually eliminates transients.—*Dep't P, Hewlett-Packard Co., 395 Page Mill Rd, Palo Alto, Calif.*

For more information circle **283** on inquiry card.

VTVM

New "Model 1060" features an input impedance of 50 megohms in parallel with 25-uf. capacitor; accuracy

2 percent on all ranges; frequency range 10 cps. to 30 kc.; five voltage ranges 0.001 to 100 volts, logarithmic voltage scale plus linear decibel scale. —*Freed Transformer Co., Inc., 1715 Weirfield St., Brooklyn 27, N. Y.*

For more information circle **284** on inquiry card.

VTVMs

New series of electronic voltmeters and ammeters for a.c. and d.c. has been thoroughly redesigned externally and improved internally. Illustrated is "MV-17" d-c. millivoltmeter. Series includes also "MV-11" d-c. micro-mi-

DC SIGNAL TRANSMISSION

...a vital contribution to complete automation

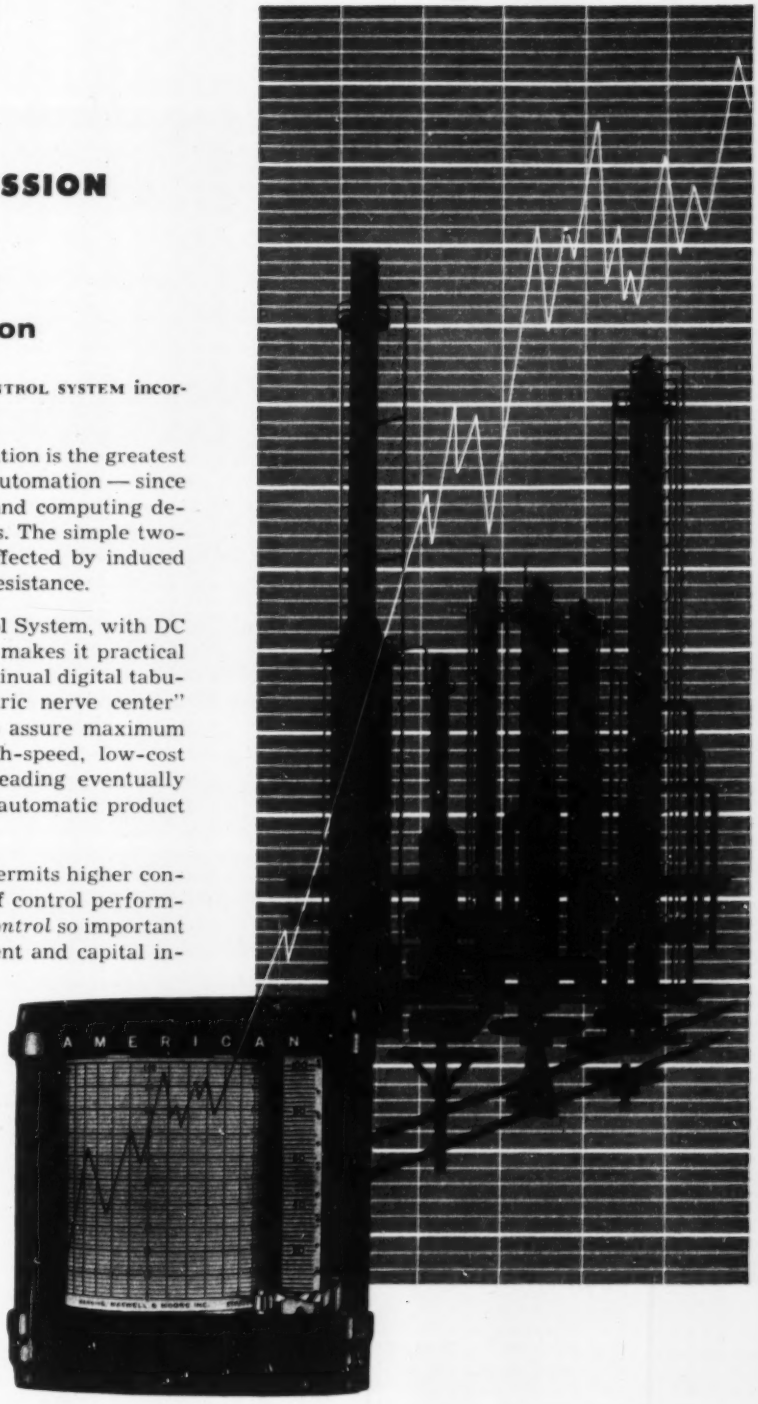
Only the AMERICAN-MICROSEN PROCESS CONTROL SYSTEM incorporates this engineering achievement.

DC TRANSMISSION of process information is the greatest compatability factor for complete automation — since most electronic print-out, monitoring and computing devices use DC in their measuring circuits. The simple two-wire DC communication lines are unaffected by induced alternating currents and varying line resistance.

The American-Microsen Process Control System, with DC transmission of process measurements, makes it practical to use automatic equipment for (1) continual digital tabulation of operational data; (2) "electric nerve center" supervision of all measured criteria to assure maximum safety and efficiency; (3) precise high-speed, low-cost accounting and engineering analysis leading eventually to the ultimate in automation — fully-automatic product analysis and control.

Instantaneous DC signal transmission permits higher controller gains — creates a new concept of control performance. It offers the *improved quality of control* so important in reducing the size of process equipment and capital investment for a given through-put.

The all-encompassing advantages of the American-Microsen Process Control System assure the highest reliability of instrument performance, minimum maintenance and the utmost in flexibility—all vital to the economical operation of the ultra modern plant of today and the standard plant of tomorrow. Your inquiry is invited. Write for Catalog 164.



AMERICAN
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MAKERS OF 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle **46** on inquiry card.

For more information circle **47** on inquiry card.

NEW INSTRUMENTS

cro-ammeter and several a-c. voltmeters.—*Millivac Instrument Corp., 444 Second St., Schenectady 6, N. Y.*

For more information circle **285** on inquiry card.

Cathode-ray Oscilloscope

New "Type 531" is designed to use plug-in vertical preamplifiers providing vertical amplifier characteristics for wide-band applications (d.c. to 10 Mc.), high d-c. sensitivity applications (1 mv./cm.), and dual-trace applications. Basic characteristics: wide-range sweep circuit—0.1 usec./cm. to 12 sec./cm. continuously variable with 24 calibrated steps; accurate 5x magnification on all ranges permitting calibrated sweep times to 0.02 usec./cm.; trigger amplitude selection or automatic triggering; d-c. coupled unblanking, 10-kv. accelerating potential on maker's new metallized CRT with helical post-accelerating anode; horizontal input amplifier sensitivity 0.2 v./cm. to 20 v./cm. continuously variable; 0.25-usec. vertical signal delay; square-wave amplitude calibrator 0.2 mv. to 100 v.; beam-position indicators show location of electron beam when off screen.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*

For more information circle **286** on inquiry card.

Volt-ohm-milliammeter

New models of "Model 260 Volt-Ohm-Milliammeter" incorporate a new utility handle, known as "Adjust-A-Vue Handle," which permits technician to set his tester at any convenient viewing angle while he is servicing.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **287** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Tubeless A-c. Voltage Standard

New "Model VRS-AC10," for calibrating indicating instruments and oscilloscopes, uses no tubes, has three ranges: 1 to 100 mv., 100 mv. to 1 v. and 1 to 10 v. Accuracy 0.25 percent. Input 115 v.ac. ± 10 percent; output loading: 1 megohm or higher, may be short-circuited without damaging instrument.—*Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.*

For more information circle **288** on inquiry card.

Pulse Generator

New "Type 1217-A Unit Pulser" makes available continuously-adjustable pulse durations from 0.2 usec. to 0.06 sec. at 12 fixed frequencies from 30 cps. to 100 kc. and provision is made for external triggering at any frequency below 100 kc. Generator is capable of approximating all three basic pulse-source waveforms: impulse, step function , and periodically repeated pulse of adjustable duration. —*General Radio Co., Cambridge 39, Mass.*

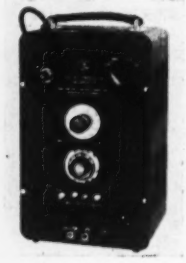
For more information circle **289** on inquiry card.

Frequency Calibrator for WWV Reception

New "RH-10" is an improved model of maker's frequency calibrator utilizing transmission from NBS station WWV. It is pre-tuned to receive WWV's 5- and 10-Mc. signals; has selector switch for standard WWV signal, 440-cps. modulation, 600-cps. modulation, or beat carrier. Sensitivity exceeds 1.0 microvolt on any band; selectivity 10 db at 5 kc. off resonance; image rejection better than 50 db; local oscillator voltage regulation to minimize drift.—*Browning Labs, Inc., 750 Main St., Winchester, Mass.*

For more information circle **290** on inquiry card.

D-c. and A-c. Calibrator



New "Model 420 Calibrator" is a triple-purpose instrument combining stable d-c. and a-c. voltage sources and having 0-10-v. output range for three selectable outputs: d.c., rms. and peak-to-peak of a 1000-cps. sine wave. Setting resolution 0.01 percent for outputs above 10 mv. and 1 uv. below 10 mv.—*Ballantine Laboratories Inc., Boonton, N. J.*

For more information circle **291** on inquiry card.

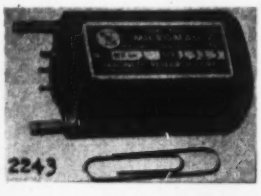
Coupling Unit

New "Type 564-A Coupling Unit" permits coupling an external oscillator into maker's "Type 260-A Q Meter" for Q measurements in audio and supersonic frequency ranges.—*Boonton Radio Corp., Boonton, N. J.*

For more information circle **292** on inquiry card.

D-c.-signal Converters

New "Micromag" static magnetic low-level d-c. converters produce phase-reversing a-c. output sinoidal



voltage in response to a polarity-reversing d-c. input voltage. Utilizing no vacuum tubes or moving parts, they exhibit a constant conversion gain over a wide ambient temperature range; can be used in place of mechanical choppers. Two basic types: "MF" produces an a-c. output voltage of same frequency as excitation voltage; 60- or 400-cps. excitation frequency. "MH" produces an a-c. output voltage which is second har-

Ratio and phase angle test on an EHT instrument transformer

Instrument Transformers

for current and voltage are most suitably tested with the new

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INSTRUMENT TRANSFORMER TEST SET

employing the differential method

Here are some important features of this modern test set:

a) for any frequency between $16^{2}/_{3}$ and 60 cps
b) for secondary transformer ratings between 1 and 10 A and from 46 to 140 V
c) burden meter incorporated
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Here are some prominent users of this test set:

DENMARK	Laur. Knudsen, Mekanisk Etablissement A. S, Copenhagen
FRANCE	Ateliers de Constructions Electriques de Jeumont
GERMANY	Physikalisch-Technische Bundesanstalt, Abt. II, Brunswick
ITALY	Scarpa & Magnano, Via Fiume, Savona
NETHERLANDS	Gemeente-Electriciteitsbedrijf, Dordrecht
SPAIN	Union Electrica Madrileña S. A., Madrid
SWITZERLAND	Moser-Glaser & Co. A. G., Muttenz (Basel)

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HARTMANN & BRAUN AG FRANKFURT/MAIN

For more information circle **48** on inquiry card.

EPLAB
Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

**Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.*

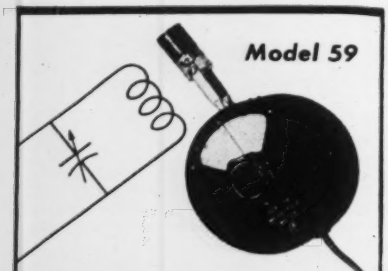
***BULLETIN No. 3 ON REQUEST*—Address: 2 Sheffield Ave., Newport, R. I.**

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

NEWPORT, RHODE ISLAND, U. S. A.

For more information circle **49** on inquiry card.



MEGACYCLE METER

2.2 mc. to 400 mc.

Frequency Accuracy ±2%

The MULTI-PURPOSE INSTRUMENT

- For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, coils.
- For measuring capacitance, inductance, Q, mutual inductance.
- For preliminary tracking and alignment of receivers.
- As an auxiliary signal generator; modulated or unmodulated.
- For antenna tuning and transmitter neutralizing, power off.
- For locating parasitic circuits and spurious resonances.
- As a low sensitivity receiver for signal tracing.

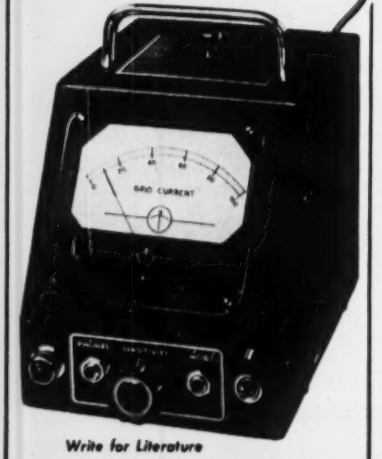
And Many Other Applications

FREQUENCY: 2.2 mc. to 400 mc.; seven plug-in coils.

MODULATION: CW or 120 cycles; or external.

POWER SUPPLY: 110-120 volts, 50-60 cycles; 20 watts.

DIMENSIONS: Power Unit: 5⅛" wide, 6⅛" high, 7½" deep. Oscillator Unit: 3¾" diameter, 2" deep.



Write for Literature

MEASUREMENTS CORPORATION

BOONTON NEW JERSEY

For more information circle **50** on inquiry card.

NEW INSTRUMENTS

monic of excitation voltage; any excitation frequency between 60 and 10,000 cps.—*Magnetic Research Corp., 318 Kansas St., El Segundo, Calif.*

For more information circle **293** on inquiry card.

Sawtooth Generator

New "Model 54 Auto-Sweep" obviates need of constantly readjusting coarse and fine frequency and synchronizing controls while making a series of tests. It locks onto any signal in its normal frequency and voltage range, synchronizes automatically, and generates a sawtooth sweep voltage of constant amplitude at one half of input frequency.—*Audio Instrument Co., Inc., 133 West 14 St., New York 11, N. Y.*

For more information circle **294** on inquiry card.

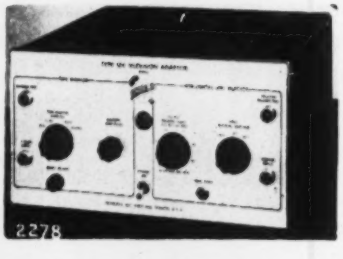
Decade Delay Lines

New decade-delay networks for laboratory use conform to advanced computer and radar requirements; are true decade-delay lines and not tapped systems. Four units: a 5 usec. line in steps of 0.025 usec., 10- and 20-usec. lines in 0.05-usec. steps, and 50-usec. in 0.1-usec. steps.—*ESC Corp., 578 E. 161st St., New York 56, N. Y.*

For more information circle **295** on inquiry card.

TV Adapter for 'Scopes

New "Type 124" adapts any triggered wide-band oscilloscope to observation of TV composite video signal. Its delayed-trigger output is continuously variable from zero to 25 milliseconds after receipt of a vertical sync pulse. Duration of output pulse is less than 1 usec. and amplitude is 2 v. positive. Triggering may be accomplished by composite video signal of either polarity, 0.5 v. minimum to 20 v. maximum, peak to peak, or a 60-cps. sine wave. Time-marker intervals are 1, 0.1 and 0.05 usec. and 0.005 *H* (200 per TV line).—*Tektronix, Inc., P. O. Box 831, Portland 7, Ore.*



For more information circle **296** on inquiry card.

Continuously-variable Time Delay Passive Network

New "Type 303," for time delay matching or phase measurement of TV systems, has resolution time less than 5 X 10^{-10} sec., passing signals of any waveform; no time jitter. Consists of an input amplifier, an output amplifier, and a continuously-variable delay line which may have ten variations, shortest 0 to 0.05 usec. and longest 0 to 0.8 usec.—*Advance Electronics Co., 451 Highland Ave., Passaic, N. J.*

For more information circle **297** on inquiry card.

AMPLIFIERS

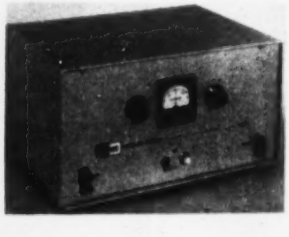
Magnetic Amplifiers

New "SMA Series" magnetic amplifiers are for 115-v.ac. input; "SMA6" for 60 cps. 4½x3¾x-3⅞ in. high; "SMA4" for 400 cps. 4⅛x3-5/16 x4-3/16 in. high. They are for use with maker's servomotors.—*Ketay Mfg. Corp., 555 Broadway, New York 12, N. Y.*

For more information circle **298** on inquiry card.

D-c. Amplifier

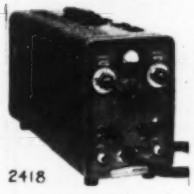
New "Model 103" wide-band d-c. decade amplifier provides step-wise variable gains of 0, 20, 40, and 60 db from d.c. to high a-c. frequencies. Chopper-stabilized amplifier circuitry produces drift-free operation. Ade-



quate feedback and frequency-corrective networks to provide flat response. Output voltage range 100 v. (+ or −); max. output current 10 ma.—*Kalbfell Labs., P. O. Box* 1578, *San Diego* 10, *Calif.*

For more information circle **299** on inquiry card.

Traveling-wave Amplifiers



Two new traveling-wave amplifiers with a distinctly new coupled helix design provide 30 and 35 db gain over 2,000 to 4,000 Mc. band; feature low noise amplification, a full watt of power output, and millimicrosecond pulsing over a full 2,000 Mc. frequency spectrum. Two models: "490A" for all types of high-gain broad-band low-noise 35-db amplification; "491A" provides a full watt of power output for high-level measurements.—*Hewlett-Packard Co.,* 395 *Page Mill Rd, Palo Alto, Calif.*

For more information circle **300** on inquiry card.

'Scope Plug-in Preamplifier

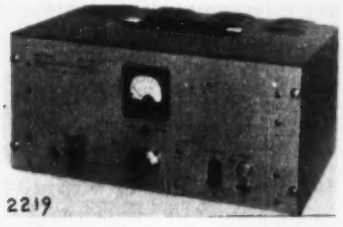
New "Type 53B" is fourth of a series of plug-in units for use with "Type 531" and "Type 535" oscilloscopes. Characteristics: 0.05 v./cm. to 50 v./cm. sensitivity, a.c. and d.c., continuously variable, with nine calibrated steps, d.c. to 10-Mc. passband, 0.035-usec. risetime; three additional calibrated sensitivity steps, a-c. coupled only, 5-cps. to 9-Mc. passband, 0.04-usec. risetime.—*Tektronix, Inc., P. O. Box* 831, *Portland* 7, *Oregon*

For more information circle **301** on inquiry card.

POWER SUPPLIES

D-c. Power Supply

New "Type 3-132 Power Supply," designed for excitation of multiple strain gages and other resistance-type



pickups, may be used also as a secondary reference voltage source. Output 0-15 v.dc. continuously adjustable, with 1-amp. maximum. By plugging accessory "No. 3-002 Stabilizing Unit" into chassis socket, output drift is reduced to less than 1 mv. in 24 hours.—*Consolidated Engineering Corp., Pasadena* 15, *Calif.*

For more information circle **302** on inquiry card.

Laboratory D-c. Supply

New "Model D3-300-E Multiple Power Supply," for laboratory applications, comprises four supplies: (1) 0-30 v.dc., 0.3 amp. max., regulation from no load to full load 0.003 v.; (2) identical except for current of 150 ma.; (3) zero to minus 150 v., negative in respect to No. 2, 5 ma. max.;

...thermal sensing unit

C·P·I PLUGSTAT®

—wherever temperature limit indication is required

CPI PLUGSTATS provide precise thermal warning without calibration drift. Small physical size has been combined with rugged construction. Special alloy contacts assure clean make-and-break. Capable of 200°F overshoot from high or low normal setting. Available also with AN connector. Rated at ¼ ampere, 28 volts, AC or DC resistive loads. Contacts NO or NC. Weight approx. 1.5oz.

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For more information circle **51** on inquiry card.

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MERCURY ACTUATED

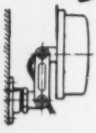
DIAL THERMOMETERS

in 3 types to suit any requirements

Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 **Rigid Stem Dial Thermometer** tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)

2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.



3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensaton. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

Write for Catalog Information

PALMER
THERMOMETERS, INC.
Norwood Ave., Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle **52** on inquiry card.

NEW INSTRUMENTS

regulated to line voltage but delivered through a 25,000-ohm, 10-turn "Helipot." (4) filament voltage, 0-10 v.ac. 10-amp. max., with a No. 10 "Powerstat" for control.—*Dressen-Barnes Corp., 250 N. Benito Ave., Pasadena 8, Calif.*

For more information circle **303** on inquiry card.

Regulated D.c. Supply

New constant-voltage selenium rectifier operates from 115-v. 60-cps. supply; is rated 30 amp. 28 v.dc. and is adjustable from 21.8 to 30.8 volts.

With an electronically-controlled saturable-core reactor, recovery time is 0.2 sec. for regulation of 0.2 percent with fixed load and 10-percent variable line or fixed line and 3-to-30-amp. variable load. Output is filtered for a maximum of 0.5 percent ripple. Ambient temperature range -20 C. to 35 C.—*Richardson-Allen Corp., 39-15 Main St., Flushing, N. Y.*

For more information circle **304** on inquiry card.

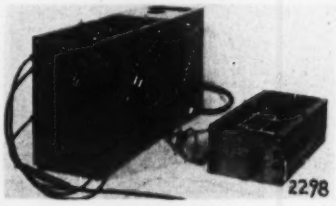
Vibration-test Power Supply

New "Model M47" rotary power supply, for use with maker's 2500-lb.-force Shaker System, covers 5- to 500-cps. range with one alternator, and 500- to 2000-cps. range with the other. It supplants previous models in which three alternators were used for the 5- to 500-cps. range alone. ★A new control console ("Model M119"), and complete line of accessories, also available.—*Calidyne Co., 120 Cross St., Winchester, Mass.*

For more information circle **305** on inquiry card.

Modular-system Supply

New regulated "Model 2 Modular Power Supply" increases flexibility of maker's "Modular System" in design



and construction of electronic equipment and quick assembly of special-function devices, by providing power to operate three or more "Modular Units."—*Audio Products Corp., 2265 Westwood Blvd., Los Angeles 64, Calif.*

For more information circle **306** on inquiry card.

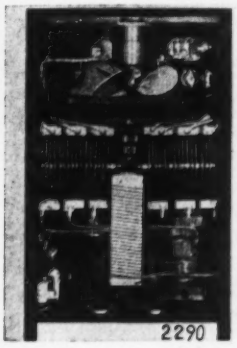
420-cps. Supply

New "Model SA-40" synchronous motor alternator converts 115-v. 60-cps. source to 420-cps. power supply; has output of 250 va. Size (approx. 7 x 11½ in.) facilitates portability. Synchronous motor maintains constant frequency.—*Electric Motors and Specialties, Inc., Garrett, Indiana.*

For more information circle **307** on inquiry card.

Regulated D.c. Supply

New "Model H-1-200" constant-voltage selenium rectifier operates from either 220-v. or 440-v. (±10%) 4-wire 3-phase 50/60-cps. supply; is rated



100 amp. 28 v.dc. or 200 amp. 14 v.dc.; has two 3-phase bridges whereby output voltage is manually adjustable from 12 to 14.5 v. or 24 to 29 v. (bridges in parallel or series). With new magnetic amplifiers, recovery time is 0.2 sec. for 5 percent regulation for 63 percent reduction in transient.—*Rapid Electric Co., 2881 Middletown Rd., New York 61, N. Y.*

For more information circle **308** on inquiry card.

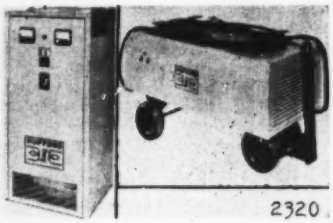
Dual-purpose Supply

New "Spinco Duostat" operates from 115-v. 50/60 cps. power outlet, provides: (1) currents from 5 to 50 ma. regulated to 2 percent at voltages ranging from 100 to 500; or (2) voltages from 160 to 500 regulated to 1 percent over a load-current range of 0 to 50 ma. Output is relatively unaffected by line-voltage changes between 105 and 125 volts.—*Specialized Instruments Corp., 554 O'Neill Ave., Belmont, Calif.*

For more information circle **309** on inquiry card.

Heavy-duty Power Supplies

New heavy-duty regulated power supplies for use on 220-440-v. 3-phase 60-cps. input are available in any de-



sired d-c. output voltages and current capacities, in stationary and mobile models.—*Electronics Div., Hufford Machine Works Inc., 2201 Carmelina Ave., Los Angeles 64, Calif.*

For more information circle **310** on inquiry card.

400-cps. Power Supply

New mobile power supply for laboratory and production is a complete package containing motor alternator, voltage regulator, exciter, etc. It supplies 400-cps. power by plugging into a 60-cps. supply (220 V., 440 V., 3-phase). Cabinet contains motor starter, output breaker, protective relays and cable storage area. Recessed instrument panel rises when power supply is in use.—*American Electric Motors, Inc., 4811 Telegraph Rd., Los Angeles 22, Calif.*

For more information circle **311** on inquiry card.

ELECTRICAL and ELECTRONIC COMPONENTS

Silicon Transistors

New silicon transistors are said to "raise power outputs and double operating temperatures" as compared to germanium. First production units are grown-junction construction as distinguished from alloyed-junction or point-contact construction; operate with little change up to 150 C. (302 F.).—*Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.*

For more information circle **312** on inquiry card.

Germanium Diodes

New "Type 1N" point-contact germanium diodes are of functional design: hexagonal body with added taper feature to indicate direction of current flow. Brown molded housing protects against humidity. Electrically inert material fills entire cavity, seals out moisture, enables units to withstand severe mechanical shock. 19 standard types.—*International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.*

For more information circle **313** on inquiry card.

Miniature Rectifiers

New "CR Series" of miniature selenium rectifiers, for load currents under 50 ma., consists of a number of selenium cells assembled within a cylindrical aluminum housing, ranging in size from 0.375 in. diam. and 0.625 in. long to 0.750 in. diam. and 0.625 in. long. New units are rated for maximum rms. input voltage of 130 and 160 for operation into capacitive load; d-c output from 10 to 50 ma.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **314** on inquiry card.

Voltage-sensitive Capacitors

New voltage-sensitive capacitors represent a new group of subminiature ceramic capacitors whose capacitance may be varied by a change in applied d-c. potential. Capacitance may be decreased as much as 60 percent by up to 500 v.dc. Their availability opens up many new applications. Inasmuch as they are also temperature-sensitive, two types are available: "Type VSR" whose voltage-sensitivity is maximal at room temperature, and "Type VSE" whose voltage

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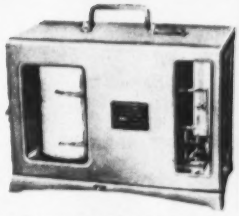
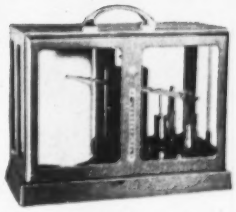
FOR RECORDING TEMPERATURE, HUMIDITY



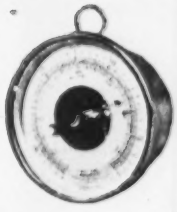
HYGRO-THERMOGRAPH The leader in its field. Noted for precise accuracy and long-time dependability. Portable, easy to operate. Widely used in laboratories, factories and offices.

PORTABLE TEMPERATURE, HUMIDITY RECORDER Rugged, compact design. Ideally suited for use in small space and difficult locations. Provides convenient 3 x 5 charts for 10 or 30 hour records.

FOR CHECKING BAROMETRIC PRESSURE



MICROBAROGRAPH A key meteorological instrument. Records atmospheric pressure to within 0.01 inch mercury. Record chart expanded 2½ times for greater visibility.



ANEROID BAROMETER Inexpensive, dependable, easy-to-read. Shows pressure and barometric tendency. Housed in handsome brass case. Favored by professionals and amateurs alike.

FOR MEASURING WIND SPEED, DIRECTION

SINGLE CHART AEROVANE RECORDER New flush mounted recorder for wind speed and direction. Each gust or lull, from breeze to hurricane, accurately ink plotted and recorded on a single continuous strip chart.

AEROVANE Indicates and records wind speed and direction. Recognized as "best all-purpose wind measuring instrument yet devised." Readily installed and easily maintained.

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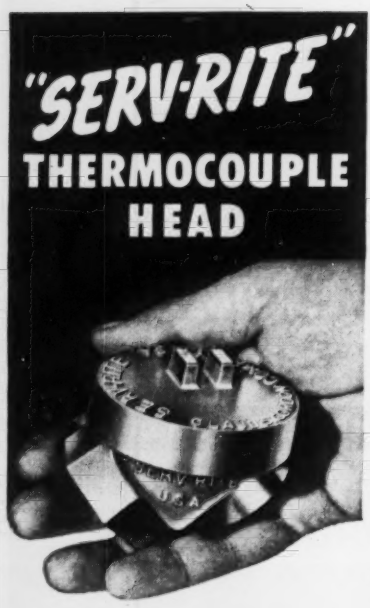
AVIATION CORPORATION

For more information circle **53** on inquiry card.



the head that's ahead in every way . . .

This new "Serv-Rite" thermocouple head is actually small enough to be held comfortably in the palm of your hand. But size is only one of the many features that make this thermocouple head really extraordinary. It is loaded with installation and service conveniences that any user of thermocouples will appreciate at once.

The body is of malleable iron, cadmium plated for durability. A new type friction lock assures easy removal or tightening of the cap — a quarter turn does it. An asbestos gasket makes the head dirt- and moisture-proof. With a choice of ½", ¾", or 1" IPS opening for the protecting tube, you can standardize on one style head.

The connector block is of a material especially selected to withstand, without damage, temperatures up to 900° F. in continuous service. Improvements over the conventional type of inserts greatly simplify the making of the lead wire connections. The complete thermocouple element, including connector block, can be easily withdrawn for inspection.

Install a "Serv-Rite" thermocouple head and see for yourself how much better it really is.

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For more information circle **54** on inquiry card.

NEW INSTRUMENTS

sensitivity is maximal at approx. 70 C. Latter is intended for use in a controlled environment, such as a small crystal-type oven, Body sizes start at approx. ⅛ in. square by 0.080 in. thick; leads are normally #26 gage tinned copper wire arranged axially. Capacitance values of approx. 300 mmf and larger may be obtained. —*Mucon Corp., 9 St. Francis St., Newark 5, N. J.*

For more information circle **315** on inquiry card.

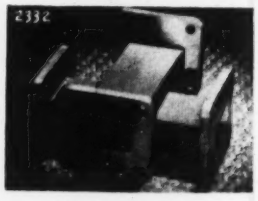
System Components

New line of components for computing, servo, radar and other systems comprises miniaturized induction resolvers, voltage dividing resistors, integrating tachometers, arbitrary function generators, and servomotors. Computing error less than 0.1 percent; maximum S/N ratios greater than 2000:1. Units come in standard BuOrd sizes 11, 15, and 23; resist corrosion, shock, vibration, fungus, and extreme temperatures.—*Mark Instrument Co., Inc., 613 Wilshire Blvd., Santa Monica, Calif.*

For more information circle **316** on inquiry card.

Directional Couplers

New series of cross guide couplers introduce a new design concept said to give superior operating performance. Characteristics of "Model



X126E": Directivity approx. 22 db or more; coupling accuracy mean coupling level within 0.4 db of 30 db; coupling variation less than 10.6 db over frequency range.—*Microwave Development Lab., Inc., 220 Grove St., Waltham 54, Mass.*

For more information circle **317** on inquiry card.

A-f. Transformers

New "Series HO" (hermetic ouncer) transformers are available in eleven types for various audio applications; feature true hermetic sealing, magnetic shielding (40-db), operation at temperatures to 200 F., paper-layer insulated coils.—*Thermador Eelectrical Mfg. Co., 2000 S. Camfield, Los Angeles 22, Calif.*

For more information circle **318** on inquiry card.

Plug-in Transformers

New plug-in miniature audio transformers, with same electrical ratings as existing catalog items, are built into a molded octal base 1-15/32 in. high by 1-3/32 in. diam.; are embedded in a high-melting-point resin. —*Microtran Div., Crest Laboratories, Inc., 84-11 Blvd., Rockaway Beach, N. Y.*

For more information circle **319** on inquiry card.

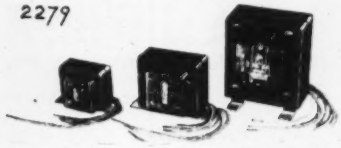
Transistor Transformer

New transistor transformer with industrial applications is available in three models: "No. 8641" transistor input, "No. 8642" transistor interstage and "No. 8643" transistor output. Impedance of "8641" primary coil is 200,000 ohms, secondary coil 1000 ohms; maximum power at 200 cps. 0.5 milliwatt. Figures on "8642" are: 20,000 ohms, 1000 ohms, max. power at 100 cps. 1 mw. For "8643" 1000 ohms, 100 ohms and max. power at 120 cps. 15 mw. Other models to order.—*Dep't KP, Telex, Inc., Telex Park, St. Paul 1, Minn.*

For more information circle **320** on inquiry card.

Transformers and Reactors

New "Telectrans" are custom plastic-molded transformers and reactors featuring a novel method of plastic



encapsulation, said to "make obsolete both the conventional hermetically sealed transformer and the use of hermetically sealed solder terminals." Sealed flexible leads can be supplied in any length. Approved by Signal Corps Engineering Laboratories; meet MIL-T-27, Grade 1, Class A.—*Telectro Industries Corp., 35-18 37th St., Long Island City 1, N. Y.*

For more information circle **321** on inquiry card.

Step-function VDR

New "Model 108" step-function voltage dividing resistor with extremely sensitive response is available for use in torque amplification devices. Entire voltage output is obtained over a 3-deg. shaft rotation. Thus, voltage sensitivity is more than one hundred times that of conventional one-turn VDR. Sensitivity is due to use of a specially-shaped carbon-film element of virtually infinite resolution. "Model 108" has ball bearings and flange-type mounting; "Model 108J," sleeve bearing and alternate bushing or flange-type mounting.—*Computer Instruments Co., 1964 Utica Ave., Brooklyn 34, N. Y.*

For more information circle **322** on inquiry card.

Precision VDRs

New "Models 162C, 200C, and 300C" are similar to "Models 162, 200 and 300" precision 1⅝-in., 2-in. and 3-in. OD single-turn voltage-dividing resistors but have added feature of stainless-steel Class 5 ball-bearings. —*George Kattray & Co., Inc.*, 116-08 *Myrtle Ave., Richmond Hill* 18, *N. Y.*

For more information circle **323** on inquiry card.

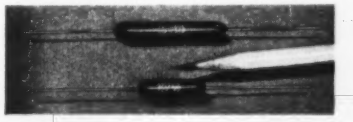
Sine-cosine VDR

New "RL11C Sine-Cosine Potentiometer" provides two output voltages, accurately (within 0.5 percent) proportional to sine and cosine of angle of shaft rotation. Among features: ball bearings, precious metal contacts and silver slip rings. Standard winding resistance 16,000 ohms; rating 1.5 watts at 65 C. Case diameter 2 5/16 in.—*Rawson Electrical Instrument Co.*, 110 *Potter St., Cambridge, Mass.*

For more information circle **324** on inquiry card.

Miniature Power Resistors

New "Blue Jackets Types 27E and 28E" are truly miniaturized self-mounting wire-wound resistors in 5-



and 10-watt sizes; are said to fit ideally in dip-soldered subassemblies; meet RETMA and MIL humidity performance requirements.—*Sprague Electric Co.*, 43 *Marshall St., North Adams, Mass.*

For more information circle **325** on inquiry card.

Boro-carbon Resistors

New "Borohm" ½-, 1-, and 2-watt boro-carbon resistors are made by a new process which permits complete control of quality and distribution of boro-carbon film; automatic control of rod and gas temperatures; resistance for a given size rod predictable and reproducible.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **326** on inquiry card.

Tone Control with Changeover Switch

New "Type LRSS-150" 0.5 watt control replaces former "LPSS-3"; features space and weight savings; has "SS-150" slide switch which operates at either extreme of shaft rotation.—*Electronic Components Div., Stackpole Carbon Co., St. Marys, Penna.*

For more information circle **327** on inquiry card.

Trimmer Resistors

New "Welwyn Type 3A7341 Subminiature Trimmer Potentiometers," for use as preset adjustable resistors in miniaturized equipment, are attached to chassis or graphic circuits by means of mounting lugs. Diam. 0.53 in., depth 0.281 in. Adjustment is made by means of a concentric tool with outer sleeve provided with two

Circle **55** on inquiry card. ⟶

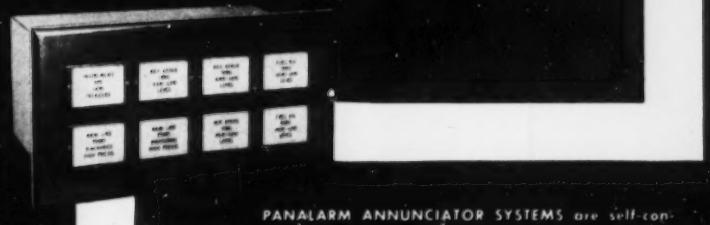
PANALARM "50" ANNUNCIATOR SYSTEMS

NEW functional flexibility with NEW "instrument-type" construction

PANALARM "50" PLUG-IN UNIT . . . hermetically sealed and most versatile ever developed . . . simply plugs into chassis to expand system . . . no wiring . . . no other connections. Corrosion-proof and suitable for Class I, Div. 2 locations.

Built-in flexibility of PANALARM "50" allows simple change-over to any operating sequence as required by present or future conditions. And, at the same time PANALARM "50" introduces a new instrument-type annunciator construction . . . adding to the long-term dependability of the entire system.

CABINET is substantial gauge steel with sturdy chassis and sub-door arrangement. It is pre-wired ready for installation, yet completely flexible without re-wiring.



PANALARM ANNUNCIATOR SYSTEMS are self-contained with either illuminated name-plates or bull's-eye visual signals. Both the audible signal and acknowledgment button are common to the entire system.

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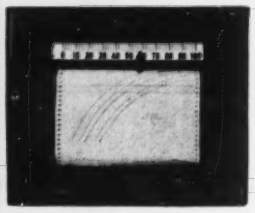
special *ElectroniK* recorders



function plotter

Automatically plots one variable directly as a function of another. One variable actuates the pen; the other, the chart drive. 11 inches full travel of both X and Y axis. See Data Sheet No. 10.0-5a.

duplex two-pen recorder

Simultaneously measures any two independent variables. Two separate measuring systems, each driving a pen which can traverse the full 11-inch chart. Any desired combination of ranges. See Data Sheet No. 10.0-6.

duplex function plotter

Two-pen version of the Function Plotter. Plots two different "X" variables as a function of a common "Y" variable. Wide selection of ranges for pens and chart measuring systems. See Data Sheet No. 10.0-17.

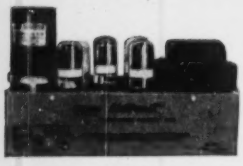
narrow span potentiometer

Measures spans as narrow as 100 microvolts, readable to 0.1 microvolt . . . needs no pre-amplifier. Available as a precision indicator, strip chart recorder, or circular chart pneumatic controller. See Data Sheet No. 10.0-8.

½-second recorder

Pen speed is only ½ second for full 11-inch chart travel. Improved velocity damping prevents overshoot. Chart speeds as fast as 4″ per second are available. See Data Sheet No. 10.0-13.

components



amplifiers

For use with converter and balancing motor, for null detection and error signal correction. See Data Sheets 10.20-3a and 10.20-4.

Amplifier No.	Input Impedance (ohms)	Sensitivity* (volts)	Overall Voltage Gain
357504-20	80,000	3×10^{-6}	1×10^{6}
357504-21	80,000	1×10^{-6}	3×10^{6}
357504-5	400	4×10^{-6}	1×10^{6}
356899	2,200	$.05 \times 10^{-6}$	40×10^{6}

*Approximate sensitivity, when used with motors listed below.

balancing motors

2-phase induction, reversing

Totally enclosed, self lubricated. High torque at low speeds. See Data Sheet No. 10.20-2b.

Ratings for 115 volt, 60 cycle operation†				
Shaft Speed, rpm	27	54	162	333
Maximum Torque, inch-ounces	85	43	19	11
Intermittent Rated Torque, inch-ounces	30	15	5	4
Maximum Power, inch-ounces per minute	6300 at 17-18 rpm	6700 at 35 rpm	8150 at 100 rpm	8750 at 190 rpm
Power Required, all speeds	Line Field, 9.5 watts Amplifier Field, 4 watts			

†Motors for 25 and 40 cycle service are also available. Above motors may be used on 50 cycles.

converters

Proved by years of service in *ElectroniK* recorders. Convert low power d-c signals to alternating voltages at nominal frequencies of 25, 40, 60 or 400 cycles. For null detection or error voltage measurement. Extremely low thermal emf; thorough shielding against pickup. See Data Sheet 10.20-1.

Electrical Characteristics of 400 cycle Converters (60 cycle converters similar except as noted)

Driving Coil Input: 18 volts, 94 milliamperes, 400 cycles (within 10%). (60-cycle model: 6.3 volts, 60 ma.)

Contact Rating: SPDT switching. Nominal rating 6 volts to 1 microvolt. 1.0 milliampere, maximum power, 100 microwatts.

Symmetry: Within 5%.

Vibration Resistance: Output voltage varies less than 2% under accelerations up to 10 g.

Stray Pick-up: Electrostatic: 2×10^{-10} volts per ohm of input circuit impedance. Electromagnetic: 2×10^{-5} volts, constant to 2×10^{-6} volts.

For more information circle **56** on inquiry card.

adjustable span recorder

The instrument of a hundred ranges. Calibrated dials on front of the case permit adjustment of span from 1 to 50 millivolts . . . shift of zero by plus or minus 100% of maximum span. See Data Sheet No. 10.0-10.

high impedance recorder

Records data from sources having impedance ranging from 0 to 50,000 ohms, with negligible loading effect on source. Spans down to 2 mv. Excellent stray rejection. See Data Sheet No. 10.0-14.

ElectroniK null indicator

The modern successor to the galvanometer is this electronic d-c null balance detector. Needs no special mounting. Vibration-resistant, stable and fast. Takes heavy overloads; no "loss of spot." Sensitivity 0.6 x 10^{-9} amp/millimeter. See Data Sheet 10.0-12.

Instruments and Servo Components *for research work*

YOUR own research program can be accelerated through the use of these and many other *ElectroniK* instruments, Brown Electronic Components and special primary elements. Your nearby Honeywell field engineer will be glad to consult on your specific requirements. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

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This and the following features make the Toolmakers' Microscope an almost indispensable instrument in your shop or laboratory.

Range 2 x 4 inches
360° Stage Rotation
Reading to 1 minute

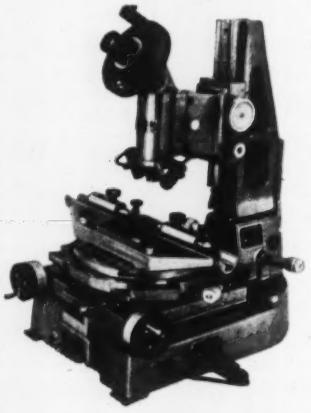
Protractor Circle
Range 360°
Reading to 1 minute

Magnification 30X

Stage Motion
By 2 inches
Precision Screws

Column Tilt 8°
For Helix Measurement

Rugged Construction
for Many Years of
Dependable Accurate Service



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INSTRUMENT ENGINEER

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For more information circle **58** on inquiry card.

key pins which permit setting contact arm for value desired. Track is carbon composition. Range of values: 1000 ohms to 1 megohm.—*Rockbar Corp., 215 E. 37th St., New York 16, N. Y.*

For more information circle **328** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Synchronous Inverter

New "Miniature Syncroverter Switch" (illustrated actual size) is a non-resonant reed-type inverter, said to be capable of operation over wide frequency and ambient temperature ranges. It is designed for converting low-power d-c. signals to alternating voltages for null detectors, electronic computers, also aircraft, missiles, gun directors, etc. It is hermetically sealed, shock- and vibration-resistant.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **329** on inquiry card.

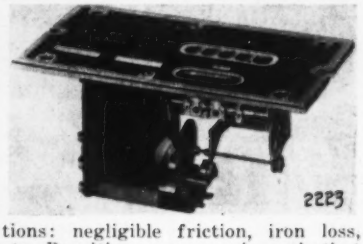
PM Motors

New 3-oz. ⅞-in. OD precision subminiature permanent-magnet d-c. motors, or rate generators, can be supplied with ball or sleeve bearings; to commercial standards or to JAN specs.; with either separate or built-in radio noise filter. Speed control governors can also be adapted. Voltages 1.2 to 27.5; speeds 2000 to 24000 rpm.; speed-reducer designed to match specific problem also available.—*Heinz A. Mueller Engineering Co., 801 No. Linden Ave., Oak Park, Ill.*

For more information circle **330** on inquiry card.

Integrating Motors

New "Low-Inertia Integrating Motors" are p-m. d-c. motors with almost perfect linear voltage/speed rela-

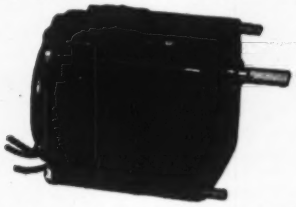


tions: negligible friction, iron loss, etc. Resulting accuracy is such that motors can yield (on digital counters, etc.) the time integrals of such millivoltages as photocell and thermocouple outputs. Illustration shows (without housing) an integrating motor combined with a mechanical counter. This complete instrument is available in four ratings.—*Electro Methods Ltd., Caxton Way, Stevenage, Herts, England.*

For more information circle **331** on inquiry card.

Instrument Motor

New "K-2RM" speed-reducer motor is designed for continuous-duty industrial applications. All gearing is heli-



cal, hobbed to AGMA Commercial Class 3 tolerances. Speeds from 280 to 0.7 rpm. with torque ratings from 2.7 to 120 oz.-in. Starting torque not less than 150 percent of full load torque at room temperature.—*Bodine Electric Company, 2254 W. Ohio St., Chicago 12, Illinois.*

For more information circle **332** on inquiry card.

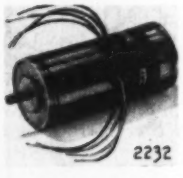
Miniature Rotary Actuators

New miniature high-torque rotary actuators are said to be "the smallest, lightest packages, for their output capacities, that are fabricated." Special

units for low backlash, water-proofing, limit switches, dynamic braking, slip clutches, follow-ups, speed governors, etc. Dimensions 2 x 5-1/16 in. maximum; up to 2000 oz.-in. torque depending on output speed. Voltages 6 to 100. —*Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.*

For more information circle **333** on inquiry card.

Aircraft Motor-generator



New "Size 51 Servo Motor with Tachometer Generator" weighs about 4 oz. Both stators are embedded in insulating compound of "extreme dielectric strength and high temperature stability." Maximum moment of inertia 2.9 gm. cm.^{2}. Motor is 400-cps. two-phase with input of 26 volts and 3.75 watts per phase; stall torque 0.35 oz.-in.; no-load speed 6500 rpm. Generator output of 0.32 volt per 1000 rpm. Units for other frequencies and voltages are available.—*G-M Laboratories Inc., 4300 N. Knox Ave., Chicago 41, Ill.*

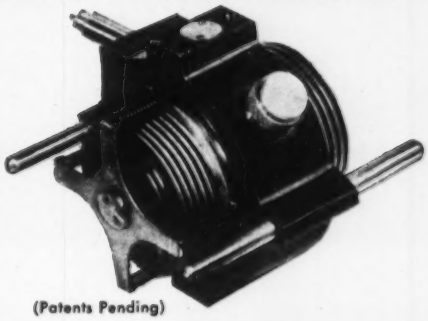
For more information circle **334** on inquiry card.

Servomotor

New "SR-43" totally-enclosed reversible motor for intermittent duty is applicable to low- or high-speed, linear- or rotary-actuator mechanisms; incorporates an automatic clutch brake which applies 2 oz-in. of brake torque to load and disengages armature automatically when power is

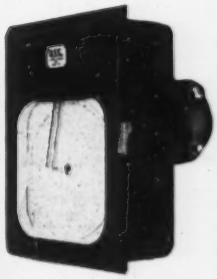
IIC® flow meters

WITH FEATURES THAT MAKE A REAL DIFFERENCE IN SERVICE

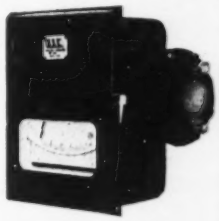


(Patents Pending)

1. Greater power, longer-calibrated travel for assured accuracy.
2. One-piece seamless, type 316 stainless steel bellows. No pitting, no welds, longer life. (Monel bellows can be furnished for special services.)
3. An exclusive I.I.C. development, the patented free floating Non-Freezing Instrument Bearing, makes possible a new era in flow meter accuracy.
4. Differential obtained from actual displacement of fluid and not from stem movement.
5. Over-range protection to housing rating.
6. Pulsation may be dampened in service without special tools.
7. Complete compensation for wide range of ambient temperatures.
8. All standard ranges available: 0-10" H_2O to 0-300" H_2O.
9. Working pressures up to 5,000 psi.
10. No precise leveling required.
11. Self-draining. No seal pots required.

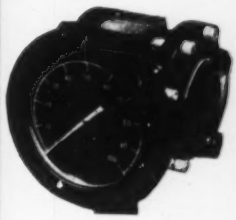


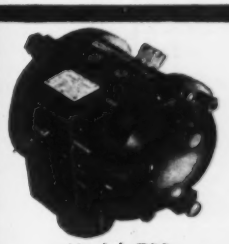
Model 802 Recorder
(Patents Pending)
IIC Model 802 Recording Flow Meter is actuated by Model 700 Meter Unit.
Simple installation. Built by experienced instrument men from a simple design, engineered for rugged duty.



Model 800 Indicator
(Patents Pending)
IIC Model 800 Indicator is actuated by Model 700 Meter Unit, is calibrated in same manner as Model 802 Recorder.

Model 800-6 Indicator
(Patents Pending)
IIC Model 800-6 Indicator is actuated by Model 700 Meter Unit. Standard 6" dials available in uniform, square root, as well as other special ranges.





Model 700 Meter Unit
(Patents Pending)
The new standard of quality for metering devices, the Model 700 Meter Unit is used by other instrument manufacturers to actuate their own differential pressure recorders, indicators, controllers and transmitters.

Write for Bulletin 56-B

IIC® INDUSTRIAL INSTRUMENT CORP.

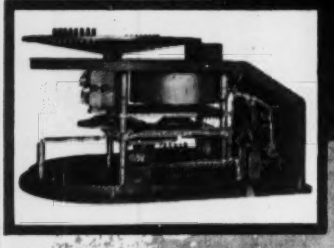
BOX 1909 ODESSA, TEXAS

For more information circle **59** on inquiry card.

Is your problem

precision calibration of rate gyros *in large quantities?*

Inside view: Genisco Rate-of-Turn Table, Model C181.



These features assure fast, accurate test data!

- Infinitely variable table speed from 0.01° to 1200° per second.
- Constancy of angular velocity within 0.1%, including wow and drift, at any rate setting.
- Special ball-disc integrator drive eliminates backlash and minute rotational irregularities.
- Unique, synchronous motor has large diameter rotor with high polar inertia; gives extremely smooth operation at all table rates.
- Up to 8 instruments (total weight 100 lbs.) can be tested simultaneously without affecting accuracy.
- Electrodynamic braking permits quick adjustments to instruments being tested.
- Repeat accuracies within 0.2% same direction; 0.5% opposite direction.
- Simple controls enable inexperienced operator to become proficient in a few minutes!
- Large expanded scale is easily read; reduces operator error.
- Noise levels below 2 millivolts per slip ring.
- Reversing operation completed automatically in 20 seconds.
- Machine may be inclined up to 35° to compensate for earth's latitude at testing site.

Read how Genisco Rate-of-Turn Tables are solving the problem for American Gyro Corporation

American Gyro designs and manufactures rate gyros for use in guided missile control systems and high speed jet aircraft. As production of these precision instruments increased, quick, accurate testing of large quantities became a major problem. After an unsuccessful attempt to solve the problem with a custom-made, gear-type machine, they turned to Genisco Rate-of-Turn Tables. The first machine was installed in May, 1953. Its use proved so successful that a second machine was added in November, 1953, as production further increased. Both machines are now operating 18 hours a day, 6 days a week. *In over six months of operation, downtime due to non-routine maintenance has been less than 3 hours on both machines!*

This performance is not unusual!

Most all major gyro manufacturers are using the Genisco Rate-of-Turn Tables with similar results. Its rugged construction, simple foolproof operation, precise repeating accuracy, and versatile mounting facilities were designed specifically for fast, accurate, production-line testing.

If your problem is laboratory or production-line calibration and evaluation of rate gyros *in any quantity*, write for complete data today. Genisco Incorporated, 2233 Federal Avenue, Los Angeles 64, California.

NEW PRECISION STROBE UNIT NOW AVAILABLE!
Provides constant frequency source for monitoring rotation rates; accurate to 0.001%!

Genisco INCORPORATED

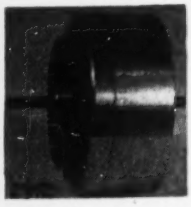
For more information circle **60** on inquiry card.

NEW INSTRUMENTS

removed. Speed 20,000 rpm at 1¾ oz-in. torque with 3.8 amps. 28 v.dc.; locked-rotor torque 10½ oz-in.—*Dalmotor Co., 1343 Clay St., Santa Clara, Calif.*

For more information circle **335** on inquiry card.

Sampling Switch

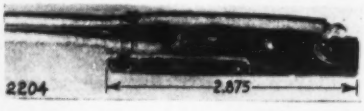


New high-speed multichannel sampling switch is of completely new design employing contact plates molded with mica-filled resin. Although unit shown is 2-in. diam. and 1-in. long, same technique applies to larger and to subminiature commutators. Available with contact materials selected according to amplication. Various features such as number of contacts, number of poles and sampling rates; single- or double-ended shaft or integrally mounted with its own driving motor.—*General Devices, Inc., P.O. Box 253, Princeton, N. J.*

For more information circle **336** on inquiry card.

High-temperature Switch

New "Model M-163 Structure-overheat Switch" is designed for surface temperature up to 1750 F. Contacts

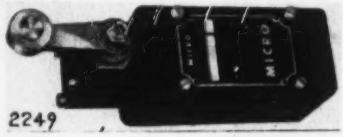


are platinum-iridium and insulation is mica. Provision is made for maintaining calibration-screw setting under vibration. High-expanding element lies directly against surface to be controlled.—*Anthony Manufacturing Co., Inc., 407-409 Main St., East Orange, N. J.*

For more information circle **337** on inquiry card.

Sealed Heavy-duty Limit Switch

New "51MLI" heavy-duty limit switch has all moving parts and contacts protected from wear, clogging



and corrosion; may be mounted in almost any position in relation to means of actuation: operating head adjustable; roller reversible on arm; actuator-arm adjustable through 360 degrees.—*Micro Switch, Freeport, Ill.*

For more information circle **338** on inquiry card.

High-speed Polar Relay

New "billion-operation" polar relay is said to feature exceptional sensitivity for high-speed pulse repeating and dependable performance where low current is transmitted over long lines; is recommended also as a differential relay in Wheatstone bridge type of control. Snap-on cover for visual inspection.—*Automatic Electric Sales Corp., 1033 W. Van Buren, Chicago 7, Ill.*

For more information circle **339** on inquiry card.

Resonant Relay

New 60-cps. model has been added to "Type 330" resonant relays (which operate only when energized at predetermined frequency). It permits use of commercial frequency in remote-control applications.—*Stevens-Arnold, Inc., 22 Elkins St., South Boston, Mass.*

For more information circle **340** on inquiry card.

Time Delay Relay

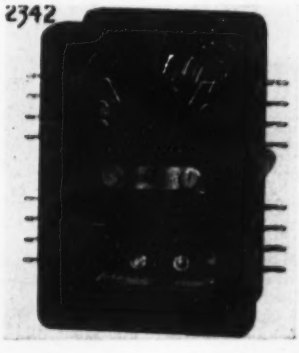
New "Model 13100" miniature hermetically-sealed time delay relay, designed primarily for 24-29-v.d.c.

airborne service (variations available for a.c. including 400 cps. and other d-c. voltages), is said to have a unique range of operation: delay of 125 to 250 milliseconds from 0 F. to 120 F., 10 *G* vibration from 10 to 250 cps. and steady-state acceleration to 50 *G*. Minimum life 100,000 operations with 3-amp. non-inductive contact loading. —*Neomatic, Inc., 9010 Bellanca Ave., Los Angeles 45, Calif.*

For more information circle **341** on inquiry card.

High-speed Relay

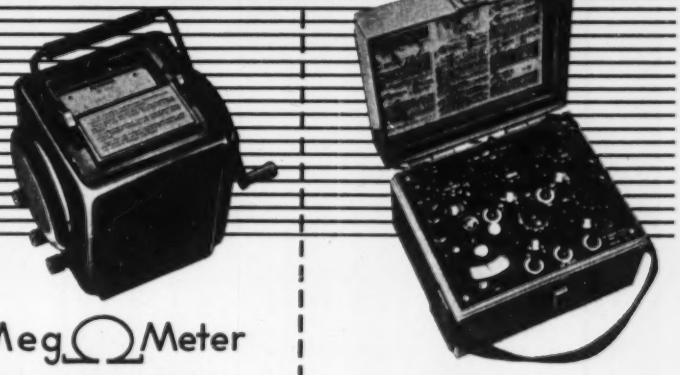
New "KP" relay was designed originally for high-speed code control systems (relay operating as often as 500,000 times daily at code speeds of 25 to 30 pulses per second). It can operate on power from 5 to 150 milli-



WINSLOW INSTRUMENTS

for accurate, reliable performance

in the laboratory, field or production line



Meg Ω Meter

FOR INSULATION RESISTANCE TESTS

- Full test potential assured because of use of true-ohmmeter (crosscoil ratiometer) indicator. This is impossible with any other type of indicator.
- Rugged casing and components withstand severe field or bench use.
- Self-contained hand-crank operated generator supplies full test voltage at all times. No batteries or external power source needed.
- Direct reading . . . no ratios to set . . . no switches to turn.
- Invaluable for checking electrical rotating equipment, transformers and all wiring.
- Meets all U. S. Military specifications.
- The only type of ohmmeter that applies full potential for all tests because of crosscoil ratiometer.

Model 5G1000 — 1000 Megs @ 500 Volt $220.00

Price includes carrying case and 3 10′ test leads. Other ranges and line operated models available.

IMPROVED WHEATSTONE BRIDGE TEST SETS

- Accuracy maintained within ±0.1% under extreme service conditions.
- Convenient operation with single dial ratio selector.
- Arranged for self-contained or external battery.
- Positive-contact, self-wiping switches — laminated blades.
- Three sensitivity ranges protect galvanometer.
- A laboratory instrument that is rugged, light weight and compact.
- Oak or waterproof aluminum case, removable cover.

Model 301W in oak case (4 Dial rheostat 1/10/100/1000, 6 ratios plus 5 special ratios for Murray, Varley, Hilborn, Fisher and other loop tests) — $168.50. Other models available.

These are just two examples of the complete line of Winslow Test Instruments . . . tested and proved for more than 25 years. SEND FOR CATALOG.

THE WINSLOW COMPANY
Manufacturers of Precision Instruments for Over a Quarter of a Century
NINE LIBERTY STREET • NEWARK 5, NEW JERSEY

For more information circle **61** on inquiry card.

UHF

. . . Ultra High Frequencies

RADIO INTERFERENCE and FIELD INTENSITY*

measuring equipment

Stoddart NM-50A • 375mc to 1000mc

Commercial Equivalent of AN/URM-17

ULTRA-HIGH FREQUENCY OPERATION . . . Frequencies covered include UHF and color television assignments and Citizen's Band. Used by TV transmitter engineers for plotting antenna patterns, adjusting transmitters and measuring spurious radiation.

RECEIVING APPLICATIONS . . . Excellent for measuring local oscillator radiation, interference location, field intensity measurements for fringe reception conditions and antenna adjustment and design.

SLIDE-BACK CIRCUIT . . . This circuit enables the meter to measure the effect of the peak value of an interfering pulse, taking into account the shaping due to bandwidth.

QUASI-PEAK FUNCTION . . . An aid in measuring pulse-type interference, the Quasi-Peak function is just one of the many features of this specially designed, rugged unit, representing the ultimate in UHF radio interference-field intensity equipment.

ACCURATE CALIBRATION . . . Competent engineers "hand calibrate" each NM-50A unit. This data is presented in simplified chart form for easy reference.

SENSITIVITY . . . Published sensitivity figures are based on the use of the NM-50A with a simple dipole antenna or RF probe. However, the sensitivity of this fine instrument is limited only by the antenna used. The sensitivity of the NM-50A is better than ten microvolts across the 50 ohm input.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

VLF
NM-10A, 14kc to 250kc
Commercial Equivalent of AN/URM-6B. Very low frequencies.

HF NM-20B, 150kc to 25mc
Commercial Equivalent of AN/PRM-1A. Self-contained batteries. A.C. supply optional. Includes standard broadcast band, radio range, WWV, and communications frequencies. Has BFO.

VHF
NM-30A, 20mc to 400mc
Commercial Equivalent of AN/URM-47. Frequency range includes FM and TV bands.

STODDART AIRCRAFT RADIO Co., Inc.

6644-D Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

For more information circle **62** on inquiry card.

watts with operating time of 5 to 15 milliseconds; is also available for pulsing speeds of 60 cps.; can be plug-connected or furnished with brackets for panel mounting.—*Union Switch & Signal Div., Westinghouse Air Brake Co., Pittsburgh 18, Penna.*

For more information circle **342** on inquiry card.

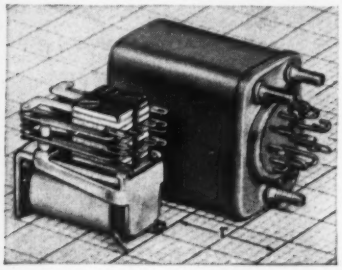
Miniature Relay

New "TQ" miniature telephone-type d-c. relay occupies 0.94 cu. in.; weighs 1.2 oz.; is available in contact combinations up to 6-p.d-t.; is vibration-resistant to 10 *G;* operates in ambient temperature from –55 C. to 85 C. on standard coil, –55 C. to 125 C. on Teflon coil. Current rating 3 amps. resistive at 26.5 v.dc.—*Advance Electric and Relay Co., 2435 N. Naomi St., Burbank, Calif.*

For more information circle **343** on inquiry card.

Subminiature D-c. Relay

New "Class 33" subminiature d-c. relay is available to meet military specifications for shock and vibration;

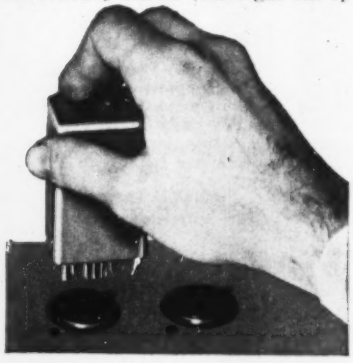


also to withstand wide temperature variations; any voltage to 110 and with up to 6 contact arms per stack, 12 arms total.—*Magnecraft Electric Co., 1442-H W. Van Buren St., Chicago 7, Ill.*

For more information circle **344** on inquiry card.

Plug-in Time-delay Relay

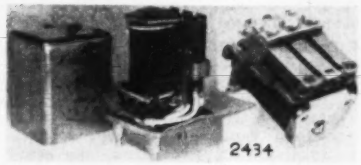
New "Type F Silic-O-Netic" time delay relay features hydraulic-magnetic silicone operating principle; is hermetically sealed (inert gas fill optionally available). Standard delay periods 0.25 to 120 sec.; octal-pin or solder-lug terminals for 24 to 220 v.ac., 12 to 125 v.dc., 3 amps. at 120 v.ac., 1 amp. at 50 v.dc.—*Heinemann Electric Co., 551 Plum St., Trenton 2, N. J.*



For more information circle **345** on inquiry card.

Miniature Relays

New "Series M and SM" are multi-purpose miniature telephone-type relays for medium-power medium-sensi-

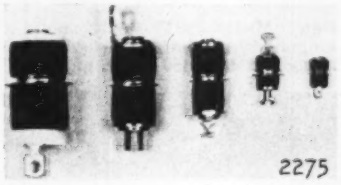


tivity applications. Among novel features: circuit resistance decreases with life; self-wipe action; new hinge provides "infinitely long" life; passes 2½-million-operation test; "Series M" up to 18 and "Series SM" up to 12 contact springs (forms A to C).—*Kurman Electric Co., Inc.*, 35-18 *37th St., Long Island City* 1, *N. Y.*

For more information circle **346** on inquiry card.

Hermetic Terminals

New solder type "Stratoseal" hermetic terminals are available for the



first time in a complete assortment. All can be solder-assembled by user. —*Stratoseal Mfg. Co.*, 3039 *Fullerton Ave., Chicago* 47, *Ill.*

For more information circle **347** on inquiry card.

Sealed Terminal

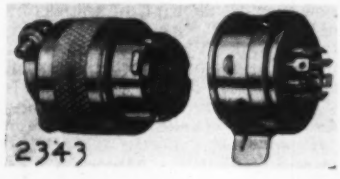
New kind of hermetically-sealed terminal for mounting either by solder or Tinnerman clip is available in either feed-through or stand-off models for

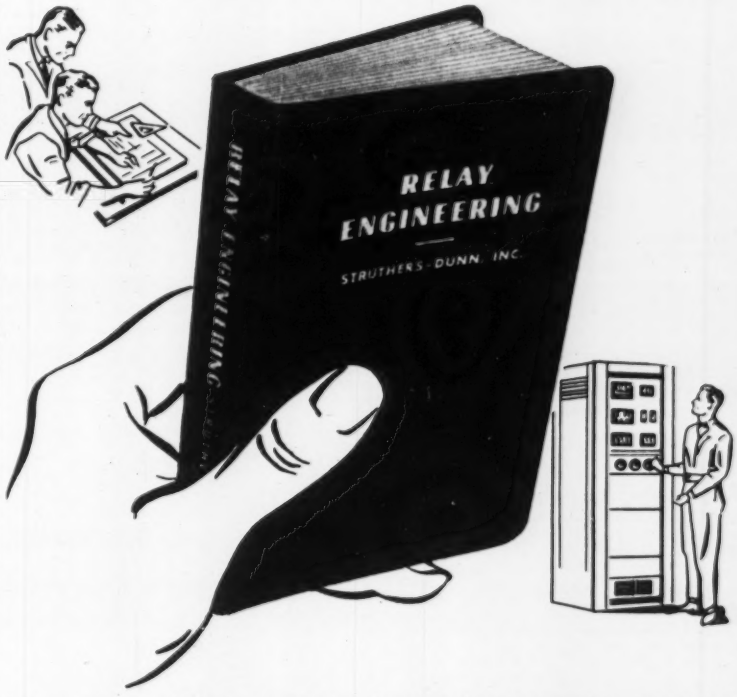
0.250-in. punched holes. Design is ceramic-to-metal; leakage resistance after water immersion greater than 10,000 megohms; voltage rating (sea level) 1,500 v. rms.; terminal-to-ring capacity less than 2.5 uuf.—*Bennett Products Mfg. Co., P. O. Box* 1055, *Palo Alto, Calif.*

For more information circle **348** on inquiry card.

Circular Connectors

New "VR and VP Series" miniature hermetic-sealed circular connectors feature Kovar type glass seal fused to base of each contact and to machined steel body. Available with one to nine





RELAY ENGINEERING*
IS MORE THAN A BOOK . . .

*

Copies of this "RELAY ENGINEERING" Handbook are available at the nominal price of $3 each. A comprehensive guide to types, selection, circuits, auxiliary equipment and maintenance, it contains 640 pages and more than 1100 diagrams, photos and data tables.

This 640-page handbook, now in its 7th printing, is used just about everywhere that relays and timers find important jobs in electrical equipment.

But "Relay Engineering" is more than just the title of a book.

It is the guiding principle of Struthers-Dunn's specialized service. For over 30 years, S-D's aim has been to design and produce relays for a wide variety of specific purposes—then to provide skilled engineering help in selecting and using these many types to best advantage.

Today, backed by over 5,348 standard types—*each designed for a purpose*—Struthers-Dunn relay engineers are in a unique position to recommend *exactly* the right relay for 4 applications out of 5.

And, by "right" we mean relays that match your requirements electrically, mechanically and costwise!

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STRUTHERS DUNN INC.

STRUTHERS-DUNN

OVER 5,348 RELAY TYPES

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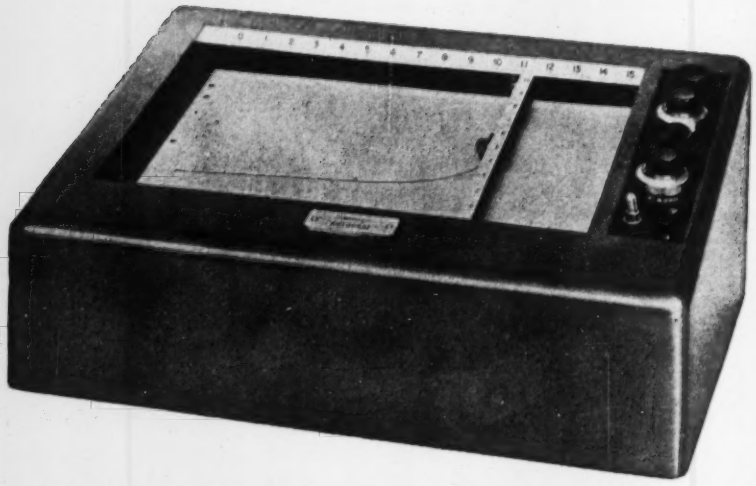
ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

For more information circle **63** on inquiry card.



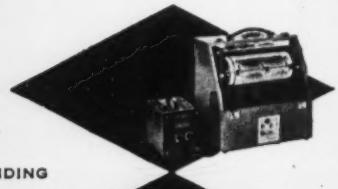
A new, large size, flat bed, versatile 2-axis recorder...

AUTOGRAF
trademark
MODEL 2

The versatility and labor-saving convenience of the original portable Autograf have now been built into an instrument which handles standard 11" x 16½" graph papers. Model 2 has the same scales and ranges as Model 1 (0-5 millivolts to 0-100 volts each axis); same speed (full scale X and Y in one second); same input impedance (200,000 ohms per volt). In addition, depressed zero available each axis, larger recording area (twice as big), flat bed, easy-reading design.

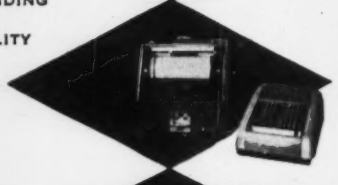
Curves are available for observation and labeling while they are being drawn.

THE AUTOGRAF MODEL 1
general purpose 8½" x 11" X-Y recorder—is doing duty in hundreds of laboratory applications: chemical, electrical, electronic, wind tunnel, computer... And on production lines: measuring motors, filters, tubes, transistors, airfoils, amplifiers, rectifiers, magnetic circuits and materials, nuclear devices, etc....

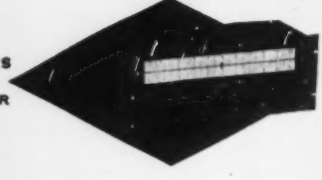


BOTH AUTOGRAF MODELS ARE OUTSTANDING FOR THEIR VERSATILITY

AUTOGRAF CURVE FOLLOWER
plots or reads out Y vs. X. Either Model 1 or Model 2 can be furnished as a recorder/curve follower.



AUTOGRAF POINT PLOTTER
Models 1 and 2 may be fitted for point plotting from keyboard or other digital sources.



NEW MODEL 20 SERIES DC VOLTMETER

A new high accuracy, easy-to-read, multi-range servo-voltmeter with fast response. Scales 0-3 millivolts to 0-300 volts. Zero left or zero center. Designed for indication, control, or analog to digital conversion.

Bulletins describing these instruments are available, and we will be glad to send you the ones you want. Write...

F. L. MOSELEY CO., 409 NORTH FAIR OAKS AVENUE, PASADENA 3, CALIFORNIA

For more information circle **64** on inquiry card.

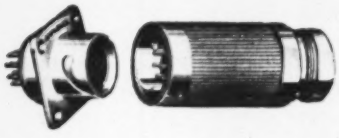
NEW INSTRUMENTS

contacts. Positive indexing. Band lock can be engaged by touch. Contacts gold-plated over silver. Current rating 5 amps.—*Viking Electric*, 1061 *Ingraham St., Los Angeles* 17, *Calif.*

For more information circle **349** on inquiry card.

Miniature AN Connectors

New "165 Series" miniature AN connectors feature reduced weight, are available in two sizes, six con-

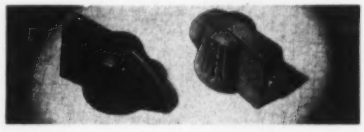


figurations, with 5, 9, 11, 12, 14 or 24 gold-plated contacts; will far exceed 50-hour salt-spray test.—*American Phenolic Corp., Chicago* 50, *Ill.*

For more information circle **350** on inquiry card.

Nylon Control Knob

New "Model 1431" knob, made of nylon, obviates need of usual metal bushing; is designed to fit any shaft

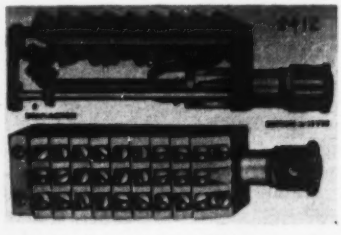


up to ¼ in. diam.; bar length 1¼ in. —*Industrial Devices, Inc., Edgewater, N. J.*

For more information circle **351** on inquiry card.

8-p. D-t. Switch

New 8-p.d-t switch, for complete control of multiple machine operations, features constant contact pressure (4



oz. per point) maintained throughout stroke until positive snap-action occurs in either direction. No dead center. Contacts handle 5 amps. 28 v.dc. inductive; 10 amps, 115 v.dc. non-inductive; 60 to 400 cps.—*Guardian Electric Mfg. Co.*, 1621-I *West Walnut St., Chicago* 12, *Ill.*

For more information circle **352** on inquiry card.

Microphone Connectors

New "Qwik" microphone connectors combine beauty with utility: bullet-shaped, smaller than existing models, designed for one-hand operation; gold-plated contacts; dielectric is "Blue 1-501" material; zinc alloy shell bodies. —*American Phenolic Corp., Chicago* 50, *Illinois.*

For more information circle **353** on inquiry card.

MECHANICAL COMPONENTS

Servo-system "Hardware"

New line of mechanical assemblies and components includes complete servomechanisms, packaged two-speed synchro, position, and rate servos. Instrument gears meeting Class 2 AGMA standards in spur, bevel, and differential types, can be supplied in coarse to fine pitch. Slotted plates and auxiliary hardware for rapid and inexpensive servo and computer layout and assembly.—*Mark Instrument Co., Inc., 613 Wilshire Blvd., Santa Monica, Calif.*

For more information circle **354** on inquiry card.

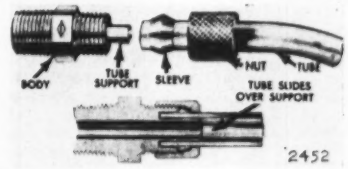
Servomechanism Lubricant

New "Servo Lube" minimizes wear and "stiction" problems on aluminum gearing. It is an anti corrosion formulation of purified molybdenum sulphide, which is brushed on and air-dries in a few moments. Surfaces treated remain dry, with a surface layer of lubricant chemically bonded to aluminum components.—*Electronic Products Co., 1315 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **355** on inquiry card.

Tube and Harness Fittings

New "Dekoron E-Z" fittings for maker's "Poly-Cor" instrument tubing harness and "P" tubing are

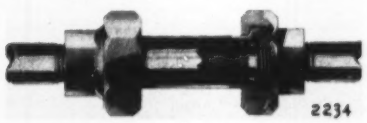


claimed to have advantages including: ease of installation, no tools required, finger tightening prevents over-tightening, absolutely leak-proof joints; withstand severe vibration and major tube movement without loosening; can be re-used. Line comprises 16 different types, each in several sizes.—*Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio.*

For more information circle **356** on inquiry card.

Straight-line Strainer

New straight-line strainer protects valves, controls, etc.; provides clean, uninterrupted flow of water, air, or



gas. All parts are non-corrosive. Available in ¼ in. to 1 in. pipe sizes. —*Hays Mfg. Co., 814 W. 12th St., Erie, Penna.*

For more information circle **357** on inquiry card.

Plastic Tubing

New "Armourvin" industrial piping is made of translucent plastic with helical steel wire imbedded in wall; will bend around a 5/16-in. diam. spin-

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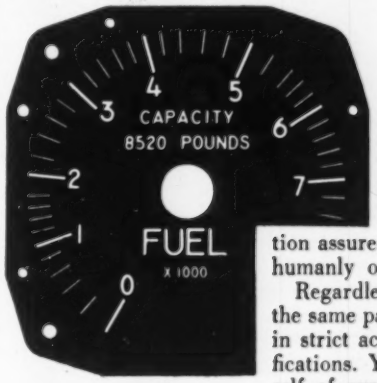

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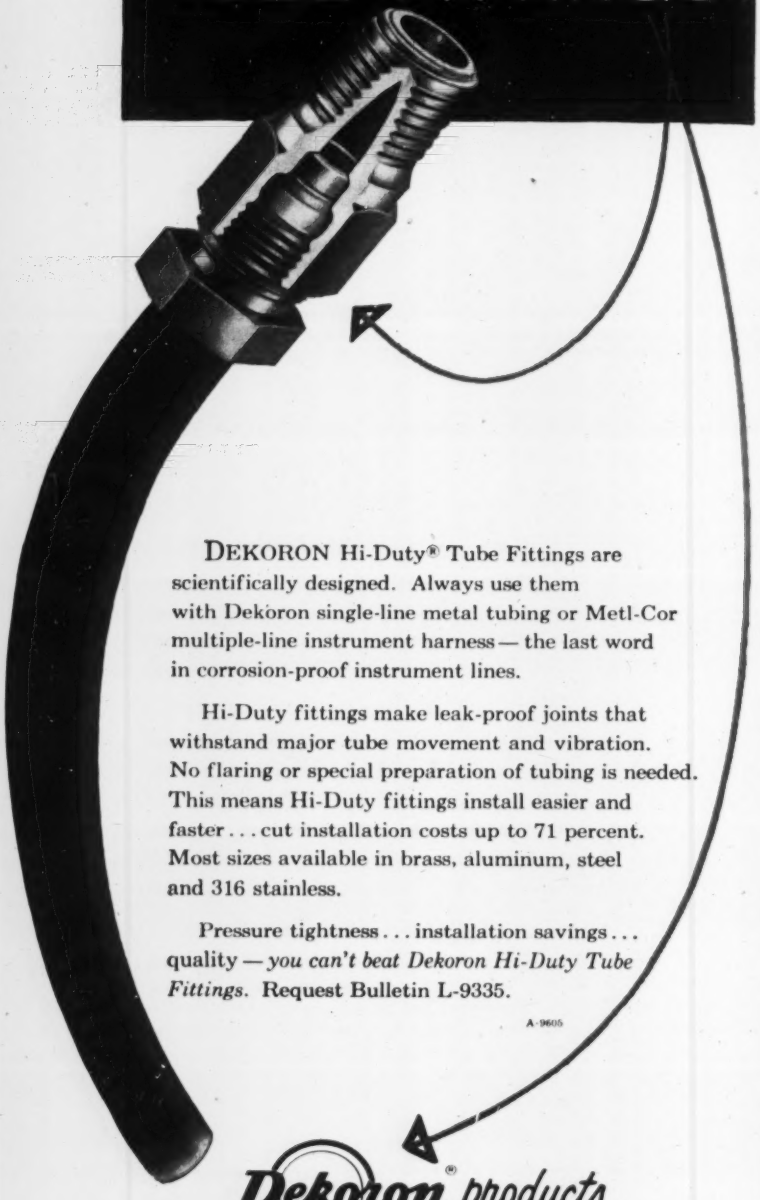
U·S RADIUM

For more information circle **65** on inquiry card.

DEKORON PRODUCTS CUT INSTRUMENT TUBING COSTS

HI-DUTY
TUBE FITTINGS



DEKORON Hi-Duty® Tube Fittings are scientifically designed. Always use them with Dekoron single-line metal tubing or Metl-Cor multiple-line instrument harness — the last word in corrosion-proof instrument lines.

Hi-Duty fittings make leak-proof joints that withstand major tube movement and vibration. No flaring or special preparation of tubing is needed. This means Hi-Duty fittings install easier and faster . . . cut installation costs up to 71 percent. Most sizes available in brass, aluminum, steel and 316 stainless.

Pressure tightness . . . installation savings . . . quality — *you can't beat Dekoron Hi-Duty Tube Fittings.* Request Bulletin L-9335.

A-9605

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DEKORON PRODUCTS DIVISION

For more information circle **66** on inquiry card.

dle without reducing internal bore; resists water, oil, grease, most acids and alkalis, coal and butane gases; remains flexible at temperatures to 70 C. and down to –40 C. Lengths up to 2 miles, ID from ⅛-in. to ½-in.—*Newage International, Inc.*, 235 *E. 42nd St., New York* 17, *N. Y.*

For more information circle **358** on inquiry card.

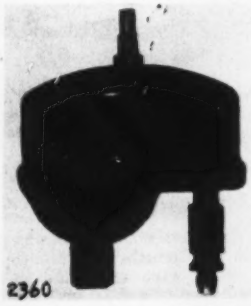
Dehydrator and Filter

New "Model CM-1 Dehydrafilter" desiccant air and gas dehydrator for isolated pneumatic equipment is rated at 1 scfm. at 100 psig. and 70 F.; features a desiccant cartridge disposable without tools. Compressed air from supply source flows downward around outside of cartridge and upward through desiccant bed. Dry air leaves after passing through a visual saturation indicator. Unit will provide dew points as low as –67 F.; is designed for straight-through installation; obviates need of electrical or steam tracing of isolated outdoor instrument air lines.—*Hankison Corp.*, 193 *Biltmore Bldg.*, 951 *Banksville Rd., Pittsburgh* 16, *Penna.*

For more information circle **359** on inquiry card.

Instrument Air Trap

New "F3030 Automatic Air Trap" is a float type water ejector which automatically discharges accumulated water from any pneumatic system. Usually piped directly into bottom of an air line filter bowl; can be applied to a drain line at any place in pneumatic system. Capacity 20 gph. Sump



for periodic cleanout of dirt.—*Industrial Equipment Div., American Injector Co., 1000 East McNichols Rd., Detroit 3, Mich.*

For more information circle **360** on inquiry card.

Heavy-duty Tube Fittings

New "Hi-Duty" leakproof tube fittings withstand severe vibration and major tube movement and are said to

NUT AND SLEEVE WITH GROOVE
BODY
DEKORON HI-DUTY FITTING WITH NUT REMOVED
SLEEVE SHEARS OFF AT GROOVE
SECTION THROUGH HI-DUTY FITTING AFTER ASSEMBLY

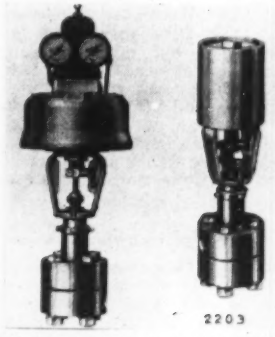
effect savings in installation time of "36 percent compared to compression fittings, and up to 71 percent compared to flared fittings."—*Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio.*

For more information circle **361** on inquiry card.

VALVES

High-pressure Valves

New "Series 34" valves for pressures to 6000 psi. and temperatures to 900 F. include pictured "Model

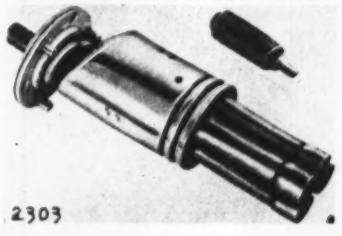


3460" (Domotor-operated) and "3420" (cylinder-operated); also manually-operated models. Valves are furnished in ½-in. and ¾-in. sizes in a wide selection of body and trim materials, in both offset globe and angle bodies. A companion line suitable for inlet pressures to 10,000 psi. is also in production.—*The Annin Company, 6570 E. Telegraph Road, Los Angeles 22, Calif.*

For more information circle **362** on inquiry card.

Heat-pump Valve

New hermetically-sealed manually-operated four-way reverse flow valve is for use in window-type air-condi-



This NEW METHOD DRIES AIR

PRECISELY as you want it

- to control your product's quality
- to prevent condensation on your product or material
- to prevent changes due to moist air in contact with your product
- to protect your material from dampness
- to protect your processing of moisture-sensitive material
- to DRY your material or product
- to pack or store your product safe from moisture damage
- to get exact moisture control for the precise atmosphere condition you need
- to provide precise atmospheric conditions for testing
- to increase your air conditioning capacity
- to DRY large quantities of fresh air from outdoors

The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always. Niagara machines using liquid contact means of drying air have given over 20 years of service.

Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

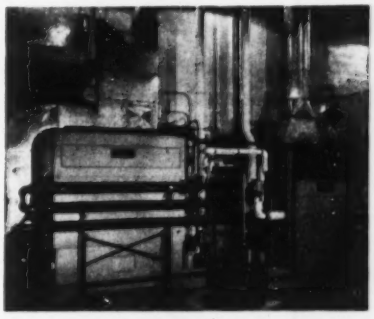
Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

Most compact, taking less space for installation.

Inexpensive to operate because . . . no re-heat is needed to obtain the relative humidity you wish in normal temperature ranges and frequently no refrigeration is used to remove moisture.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.



Niagara Controlled Humidity Air Conditioning

This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.

For complete information write

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For more information circle **47** on inquiry card.

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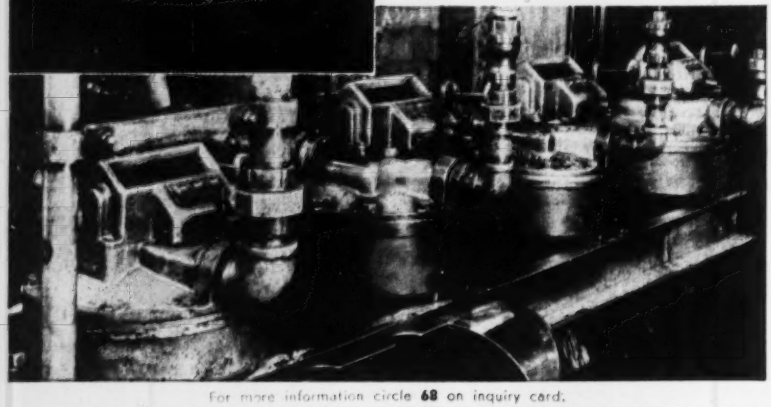
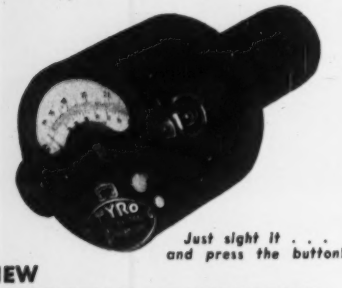


For more information circle 68 on inquiry card.

The Only Instrument You Need To Tell Spot Temperatures Instantly!



Just sight it . . . and press the button!

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Any operator can determine spot temperatures in kilns, fire boxes, furnaces, ovens, etc., *accurately—instantly*—with the New Pyro Radiation Pyrometer. No thermocouples, lead wires or other accessories needed—the PYRO is completely self-contained. Just sight it at the object . . . and press the button. Temperature indicated instantly on large direct-reading dial. Two double ranges available 1000/1800—1800/2600°F and 1400/2400—2400/3600°F. *Write for FREE Catalog No.* 100.

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For more information circle 69 on inquiry card.

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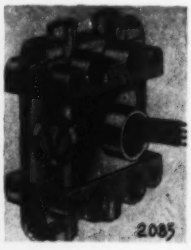
For more information circle 70 on inquiry card.

NEW INSTRUMENTS

tioning units serving dual purpose of cooling or heating rooms.—*Bridgeport Div., Robertshaw-Fulton Controls Co., 1225 Connecticut Ave., Bridgeport, Conn.*

For more information circle **363** on inquiry card.

Four-way Solenoid Valve

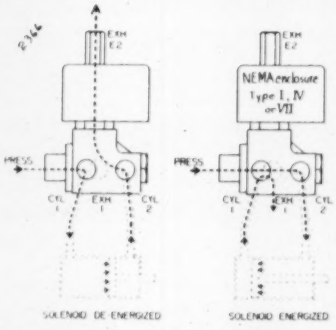


New "V9 Four-Way Solenoid Valves" are small (4-5/16 in. high), suitable for air, hydraulic oils and other common media; will operate in any position. One "V9" can control one double acting cylinder or two single-acting cylinders. 176 variations of capacities, metering and types.—*Skinner Electric Valve Div., Skinner Chuck Co., Edgewood Ave., New Britain, Conn.*

For more information circle **364** on inquiry card.

Four-way Solenoid Valves

New "Bulletin 8345" midget 4-way solenoid valves are for non-corrosive gases and liquids at pressures of 10 psi. to 125 psig. (for a.c.) and to 50

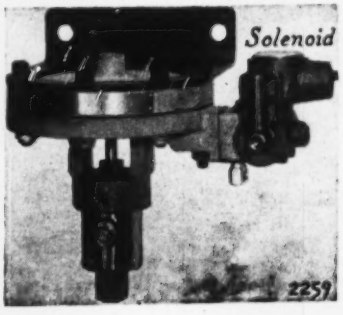


psig. (for d.c.). Pipe size ¼ in. Power consumption 10 watts. Operating speed up to 400 cycles per minute. Continuous-duty solenoid coils Class A Standard, Class H High-temp. glass silicone-impreg., or molded Luxoline for severe moisture conditions.—*Automatic Switch Co., Orange, N. J.*

For more information circle **365** on inquiry card.

High-pressure Control Valve

New air-actuated valve for on-off operations and working pressures to 30,000 psi at 450 F. is suitable for use as (1) relief valve, (2) remote sampling, (3) remote addition of chemicals, (4) reduction of dead vol-

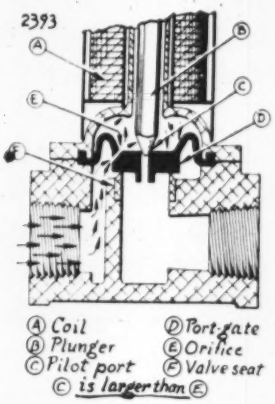


ume in systems by eliminating lines to and from control panels. Among features: removable seat, "floating" stem, manual override, and easily positioned body. It may be operated by a manual 4-way valve or by a pilot-operated solenoid valve. Solenoid valve has been made an integral part and is available in Class I, Group D, explosion-proof rating.—*Pressure Products Industries, Hatboro, Penna.*

For more information circle **366** on inquiry card.

Solenoid Valves

New "DO" (diaphragm operated) solenoid valves, for stand-by flow control and for automatic cycling operations on instruments, process control



equipment, etc., are available in six pipe sizes from ⅜-in. to 1½ in. They will operate on line pressures to 150 psi. and as low as ½ in. of water, at 40 to 60 cycles per minute. All are pilot-operated with line pressure furnishing operating force. Power is required only to lift solenoid plunger.—*Eclipse Fuel Engineering Co.*, 1011 *Buchanan St., Rockford, Ill.*

For more information circle **367** on inquiry card.

Solenoid Valve

New "Electro-Mite" is a direct-acting solenoid valve with built-in protective strainer, for on-off automatic flow control of water, air or gas lines. Optional feature: "flow volume control" to maintain set flow-rate regardless of variable pressure. Produced with ¼-in. inlet and ⅜-in. outlet; ¼-in. bushings available for outlet. Both inlet and outlet are ¼-in. when used with volume control.—*Industrial Sales Div., Hays Mfg. Co.*, 818 *West 12th St., Erie, Penna.*

For more information circle **368** on inquiry card.

Relief Valves

New "RHV" automatic reseating temperature and pressure relief valve for hot water storage heaters are calibrated; permit on-the-job pressure adjustments to be made without use of an auxiliary pressure gage. An-

MERIAM MANOMETER ACCURACY "Evaporates" BRAZING PROBLEM

A Meriam Manometer on this Electric Furnace Company Continuous Roller-Hearth Type Furnace controls the brazing of refrigerator evaporators.

The Electric Furnace Company of Salem, Ohio, selected Meriam Manometers "because of their sensitivity, accuracy and dependability". They are used in vacuum-brazing of evaporators for refrigerators, a process done in the company's special atmosphere continuous roller-hearth type furnaces.

Contactor-type Meriam Manometers precisely indicate when the required pre-determined vacuum in the evaporators is reached. At this point a contact closes and starts a timer which controls the brazing process. This Meriam Manometer functions both as a pressure indicator and as a highly sensitive switch.

As a pioneer in manometry, we specialize in fine precision instruments to indicate pressure or flow of liquids and gases. Next time you have a problem involving indication, consult your MIT* Man or write us.

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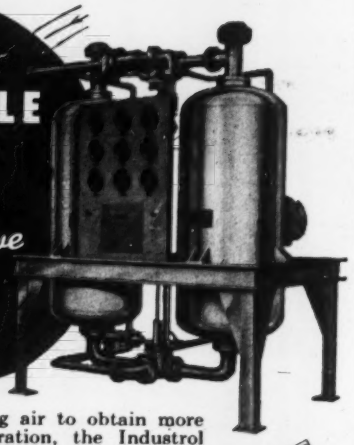
For more information circle **71** on inquiry card.

for DEPENDABLE Instrument Operation You Must Have CLEAN-DRY AIR



When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.

An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.

Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.

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For more information circle **72** on inquiry card.

MEASURE ALL 3! ★ FLUTTER ★ WOW ★ DRIFT

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FLUTTER METER

First Aid for the sound engineer — the ACA Flutter Meter! Accurate, sensitive instrument designed for rapid visual indication of flutter, wow, and drift content of discs (all speeds), sound film mechanisms, film recorders, and magnetic wire and tape recorders.

Three distinct and simultaneous readings may be made of flutter, wow, and drift. Large, sensitive 4" meter has three scales: 0.3%, 1.0%, and 3.0%, calibrated for flutter, wow, and drift readings. Accuracy within 2% of full scale value, independent of wave-form, amplitude variation, hum, noise, etc.

Flutter Meter complies with tentative standards set by Society of Motion Picture Engineers. Recommended for schools, labs, broadcast stations, recording equipment manufacturers, and studios.

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For more information circle **73** on inquiry card.

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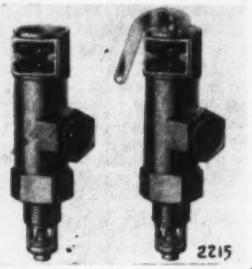
NEW INSTRUMENTS

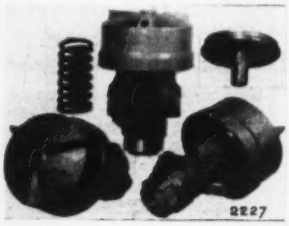


nouncement states: "There is nothing like it on the market today."—*A. W. Cash Valve Mfg. Corp., Decatur 60, Ill.*

For more information circle **369** on inquiry card.

Cylinder-top Valve

New "Type D532" valve is said to include features not heretofore available in air-powered valves. Among

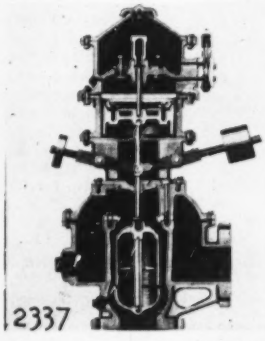


them: New cylinder top has greater power in smaller space and normal life expectancy without service. Low-friction packing withstands drying effects of steam temperatures. High finish of service area and small trapped air space. Piston casting extends to meet valve disk and its shape provides three-point guiding action for positive alignment.—*Emmett Machine & Mfg. Co., Inc.*, 2249 14*th St., S.W., Akron 14, Ohio.*

For more information circle **370** on inquiry card.

Controlled Closing Valve

New "Type CCAV Controlled Closing Valve," of completely new design, protects pipe lines against damaging effects of surge and built-up pressures or water hammer; controls speed of

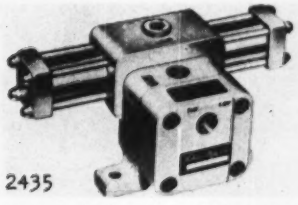


line closure; vents air and, if necessary, discharges water to prevent damage and also admits air to protect against pipe collapse from line breaks. —*Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia 42, Pa.*

For more information circle **371** on inquiry card.

Cylinder-control Valves

Two new disk-type power-operated valves are designed for actuating remotely-located cylinders; are available



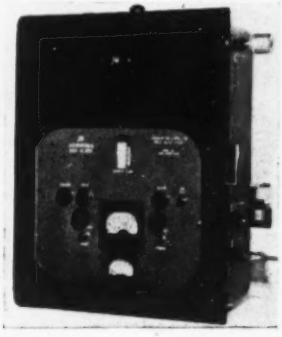
in two- and three-position forms. Among features: "free-floating piston movement eliminating alignment problems; floating piston bar; pilot valves permit many interchangeable control combinations; power return to all positions; operation by air, gas, oil or water; completely accessible for inspection. Sizes from ⅜-in. to 1¼-in. pipe connections.—*Ledeen Mfg. Co., 1600 So. San Pedro St., Los Angeles 15, Calif.*

For more information circle **372** on inquiry card.

GAS & LEAK DETECTION

Combustible Gas Alarm

New "Model SM" draws continuous sample from point of potential hazard; shows explosibility continuously. When combustibles reach a preset lev-



el (from 0.1 to 1.0 of lower explosive limit) relay actuates signal lights or horns. Special models for a two-stage alarm, usually set for first warning at 0.2, and second at 0.6.—*Johnson-Williams, Ltd., 2747 Park Blvd., Palo Alto, Calif.*

For more information circle **373** on inquiry card.

Leak-detection Liquid

New "Leak-Tec" is a liquid for detecting the most minute leaks of gas, chemicals, oils and air, by squirting it from a specially designed plastic bottle on surface being tested. It is non-inflammable, non-explosive and non-injurious to the person using it. —*American Gas & Chemicals, Inc., 45 Rockefeller Plaza, New York 20, N. Y.*

For more information circle **374** on inquiry card.

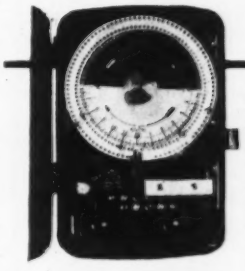
Leak Detector

New "Kinetic Leak Detector" for rapid, dry testing of instrument lines, bellows, etc., weighs 20 lbs.; requires only a supply of compressed air or inert gas. Test procedure is non-immersion: no drying and corrosion

AUTOMATIC RESET

AEMCO INTERVAL TIMERS

are engineered to excel!



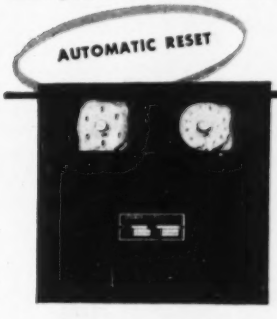
CYCLE MASTER TIME SWITCH

"THE UNIT THAT NEVER FORGETS"

Here is a low-cost quality Time Switch that gives *more* ON and OFF operations per cycle! SPST or SPDT models are available with 24 hour cycle, 12 hour cycle, 1 hour cycle with ON or OFF intervals of as little as 15 minutes, 7½ minutes, or 37½ seconds respectively. All models will handle up to 48 ON and OFF operations during cycle. Available in 10 or 20 amp. models with 4 to 8 terminal panel, with or without Sunday-and-Holiday cutout.

MAR SERIES INTERVAL TIMERS

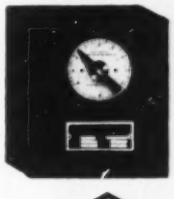
This neat, compact, surface mounted unit measures 6⅜" x 3⅜" x 3⅞". Has an open or exposed type dial on which settings from a few seconds to maximum cycling time may be made. Exposed terminal block for connecting either 110 or 220 volt A. C. only. The MAR Series has a 10 amp. capacity and is available with delayed action, instant recycling if current is interrupted or hold position until current is restored.



MARA SERIES

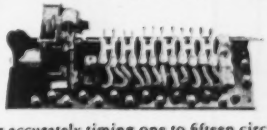
The MARA Series Timers can be supplied to operate in cycles from 10 seconds to 108 hours. In effect it is two interconnected adjustable Timers which permit varying not only the ON and OFF periods but also the length of the complete cycle. If either the open or closed circuit requires a short interval, one of the timers is provided with a very short time cycle for precise accuracy. Drawn steel case is 8" x 5" x 4½"; has a lockable metal hasp and glass windows thru which dials are visible.

MANUAL RESET TIMER — **SEQUENCE TIMER**



MMR AND MR SERIES

A neat, compact low-cost unit for the accurate timing of a single operation, such as baking, defrosting, heat treating, etc. or for signaling purposes. Models are available in cycles from 60 seconds to 96 hours, with or without buzzer and bulls eye that visually and audibly signal end of cycle.



For accurately timing one to fifteen circuits or operations in any cycle up to 96 hours. Engineered to meet specific requirements.

WRITE TODAY to our Engineering Department for information or quotations on your specialized needs.

AEMCO *Automatic Electric* MFG. CO.

58 STATE STREET · MANKATO, MINN.

For more information circle **75** on inquiry card.

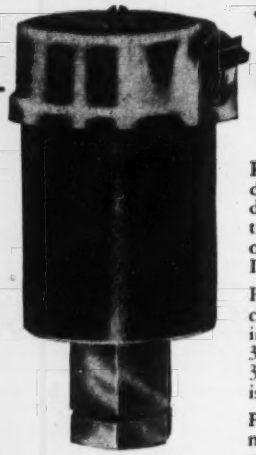
New! Atkomatic

SOLENOID

Stainless Steel

Direct Lift Valve

to 5000 P.S.I.



Rugged, simple, compact, heavy-duty, two way valve for broad industrial applications. Assures continuous service, nothing to wear out, has only two moving parts. Instantaneous action.

Features higher pressures, greater corrosion resistance. 1/8 and 1/4 inch pipe sizes, orifices 1/16 to 3/16 inch diameter. Bodies are 303 Stainless, Solenoid armature is 416 Stainless.

Pressures: 5000 P.S.I. to 150° F. maximum, 2500 P.S.I. to 475° F. maximum. Paper insulated coils up to 180° F., glass insulated, silicone impregnated up to 475° F.

Write for Bulletin No. 100

ATKOMATIC VALVE COMPANY

525 ABBOTT STREET INDIANAPOLIS 25 INDIANA

For more information circle **76** on inquiry card.

TRINITY

DOUBLE-BORE THERMOWELLS

- *Minimize the factors of error in Temperature Instrument Test Procedures*
- *Permit accurate test without removing detecting element from well*
- *Eliminate the use of separate test wells*
- *Reduce the cost of Test Procedure*

Write for Bulletin 541

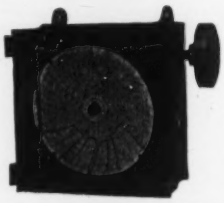
Two holes are provided in each well.
The Primary hole accommodates the detecting element of a permanently installed temperature instrument
The Secondary hole accommodates a #20 gauge test thermocouple

TRINITY EQUIPMENT CORPORATION

494 Westfield Ave., East • Roselle Park, New Jersey

For more information circle **77** on inquiry card.

Amthor



Operation Speed Recorder 8" Chart 12 or 24 hr.

Built for severe service. Users report 10, 12 or more years of trouble-free life. Powerful centrifugal speed-measuring elements stays calibrated. Non-spill reservoir pen. Special chart paper. Rugged clock movement.

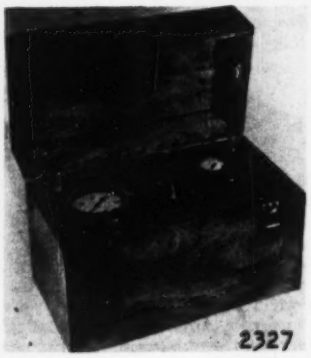
Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems. Drop us a line today

Amthor Testing Instruments Co., Inc.

49a VanSinderen Ave. Brooklyn, N. Y.

For more information circle **78** on inquiry card.

NEW INSTRUMENTS



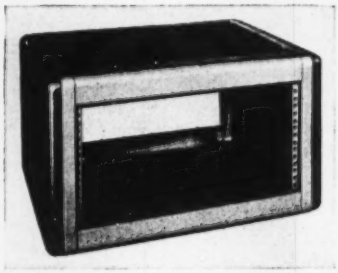
problems. Leaks can be located and repaired without disconnecting detector.—*Kinetic Engineering Co., M-217, Delaware Trust Bldg., Wilmington 1, Del.*

For more information circle **375** on inquiry card.

INSTRUMENT HOUSINGS

Instrument Cabinet

New "Emcor" instrument cabinet has top, bottom, back and both end panels removable with a screwdriver,

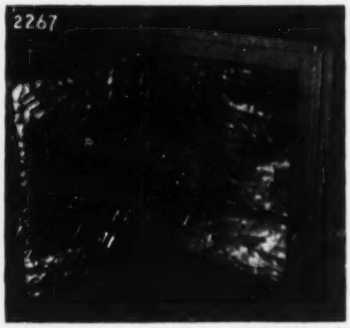


allowing complete accessibility to interior. Cabinets can be stacked vertically or horizontally; locked together in minutes. Chassis width up to 17 in.—*Elgin Metalformers Corp., 906 N. Liberty St., Elgin, Ill.*

For more information circle **376** on inquiry card.

Instrument Housings

New instrument housings come in three sizes said to accommodate 85 percent of units. Hole and flange to



slip 2-in. mounting pipe; 4-in. knockouts in sides and back; ½-in. foil-face insulation; ¼-in. wire-glass window. Shipped knocked-down.—*Rich Mfg. Corp., 250 Second St., Elizabeth, N. J.*

For more information circle **377** on inquiry card.

AIRCRAFT INSTRUMENTS

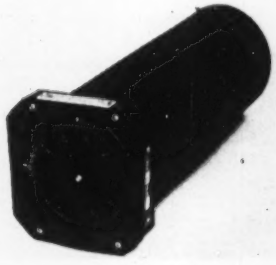
Aircraft Gyro System

New "MA" light-weight (20-lb.) compass system for aircraft has free-gyro drift rate of less than 4 deg./hr. as compared to old 12- to 18-deg. drift-rate standard; features controlled latitude-drift compensation, normal "slaving-rate" of about 2 deg./min.; has built-in synchro output for operating a radio magnetic indicator, omnirange and automatic pilot. "Secret" of accuracy is a radically designed gyro: three times angular momentum of conventional motor designs while weight factor remains the same.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **378** on inquiry card.

Remote Indicators

New "Data Repeaters" comprise (1) a photographable mechanical unit for aircraft panel mounting and (2) an



appropriate amplifier; feature an extremely high degree of accuracy. Two basic types: "Syncro Data Repeater" accepts a shaft position as input signal, and "Helipot Data Repeater" accepts a voltage (400 cps. suppressed carrier or d.c.).—*Midwestern Geophysical Lab., 3401 S. Harvard, Tulsa, Okla.*

For more information circle **379** on inquiry card.

MISCELLANEOUS

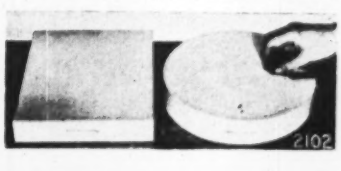
Hand Tachometer

New hand tachometer features a scale-changing device which reduces misreading of various ranges. Each of three different models has three ranges. Each consists of two basic units: contact make-and-break type head, placed against moving object; and indicator, attached by a 2-ft. flexible electric cable. Indicator incorporates a reactance circuit, a multi-scaled milliammeter, and a flashlight-cell power supply.—*Meter and Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **380** on inquiry card.

Lapping-and-polishing Stone

New "Fixed Abrasive Lapping and Polishing Stone" permits parts to be lapped immediately after surface



MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED

STANDARD

MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only* — normally open or normally closed.

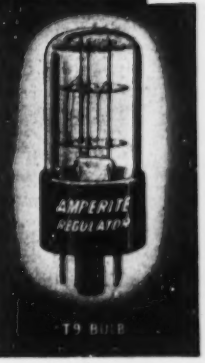
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

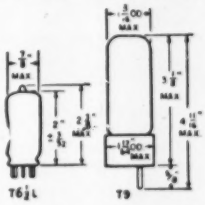
TYPES: Standard Radio Octal, and 9-Pin Miniature.

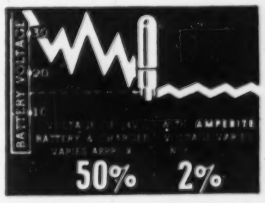
PROBLEM? Send for Bulletin No. TR-81

BALLAST-REGULATORS

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.







Maximum Wattage Dissipation: T6½L—5W. T9—10W.

AMPERITE

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

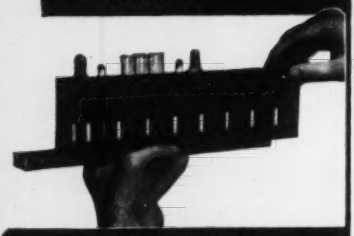
AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp. Ltd., 560 King St. W., Toronto 2B

For more information circle **79** on inquiry card.

Want the easiest way to make fast, accurate

pH, CHLORINE TESTS?



TAYLOR COMPARATORS

EASIEST...

because three simple steps give you the determination; every Taylor set is supplied with all necessary reagents and accessories. And, Taylor sets are lightweight, yet strongly built.

FAST...

because many tests can be made in only a few seconds. Others take no longer than a few minutes. Taylor sets are compact, portable so you can make tests on-the-spot, no time wasted carrying samples back to the lab.

ACCURATE...

because all Taylor liquid color standards carry an unlimited guarantee against fading.

All standards for any one determination are housed in a single plastic slide. No single standards to handle. Many different slides can be used on one base.

See Your Dealer Soon!

FREE MANUAL

"Modern pH and Chlorine Control" illustrates and describes full Taylor line. Also gives useful data on theory and application of pH and Chlorine control. Write today.

W. A. TAYLOR AND CO.
416 RODGERS FORGE RD • BALTIMORE MD

For more information circle **80** on inquiry card.

NEW INSTRUMENTS

grinding or fine machine finishing; will attain 2 microinch finish. Stock removed is easily wiped away with an oil-wetted cloth. Stone is easily reconditioned in user's own shop.—*Abrasive Engineers, 245 Waukegan Ave., Highwood, Illinois.*

For more information circle **381** on inquiry card.

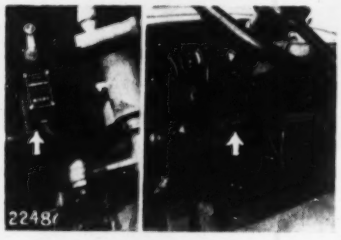
Chlorinator

New "A-701" chlorinator features improvements including: (1) dual orifice meter which automatically, or by flip of switch, allows feed ranges up to 100 to 1; (2) corrosion-resistant materials; (3) linear scale reading of chlorine flow rate; (4) automatic electric, hydraulic, air or vacuum control. Maximum capacity 1000 lbs. per 24 hrs.—*Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.*

For more information circle **382** on inquiry card.

Counter for Concrete Trucks

New electric counting system for mix-as-you-go concrete trucks comprises a snap-action switch, a con-

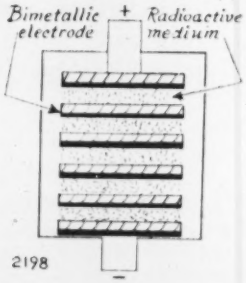


necting and sealing device, and an electric counter for use with either 6- or 12-volt d-c. circuits. Switch, actuated once every revolution of mixing drum, actuates counter located inside cab.—*Micro Switch, Freeport, Illinois.*

For more information circle **383** on inquiry card.

"Atomic" Batteries

New "atomic" batteries use radioactive tritium as source of power. Danger is negligible because beta rays emitted by tritium can be completely absorbed by a piece of newspaper. New batteries have useful life of 10



to 30 years (depending on design) during which time a constant voltage is generated while current declines at a known rate. Illustration: battery developed for U. S. Signal Corps.: provides up to 400 volts at 0.01 to 1 microwatt of power.—*Tracerlab Inc., 130 High St., Boston 10, Mass.*

For more information circle **384** on inquiry card.

Hatchet Soldering Iron

New small hatchet soldering iron weighs 3 oz., is said to be more powerful than wattage ratings indicate: 25-watt with ⅛-in. tip (No. 25H) or 30-watt with 3/16-in. tip (No. 26H); 110 or 220 volts.—*Hexacon Electric Co., 506 W. Clay Ave., Roselle Park, N. J.*

For more information circle **385** on inquiry card.

Heated Pump

New "Corson-Cerveny Heated Pump" can be equipped with steam or electrical heating, or both. It is a metering pump for viscous materials (e.g. bituminous tars) and solids like naphthalene. It can be adjusted for various rates while in operation. Jacketed burette is supplied for checking flow rates and level in heated charger.—*Research Appliance Co., 163 West View Road, Pittsburgh 9, Pa.*

For more information circle **386** on inquiry card.

Impregnating Machine

New "Dual Impregnator" represents a radically new development in vacuum impregnation. Exclusive

method is claimed to accomplish perfect impregnation in the shortest time. Five sizes, capacities from two 2-gal. to 30-gal.—*Red Point Products, Inc., 1907 Riverside Dr., Glendale 1, Calif.*

For more information circle **387** on inquiry card.

Small Rod Magnet

New low-price rod magnet, 1 in. long by 3/16 in. diam., is in quantity production.—*Carboloy Dep't, General Electric Co., Detroit 32, Mich.*

For more information circle **388** on inquiry card.

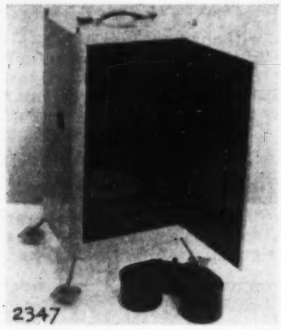
Mirror Coating

New type of instrument mirror coating said to set a new standard for durability combined with reflectivity, is applied under evacuation; has a hardness close to that of the harder precious metals and a reflectivity equivalent to pure aluminum in all regions of spectrum; is equally good for first- or second-surface mirrors; may be cleaned repeatedly without damage. An open flame produces no apparent effect.—*Houston Technical Laboratories, 2424 Branard, Houston, Texas.*

For more information circle **389** on inquiry card.

Recording Altimeter

New "Alticorder," first commercial instrument of its type, operates without attention for one week; includes a W&T altimeter, an eight-day clock, an air-temperature thermometer; a bubble level; a 35-mm. W&T camera;

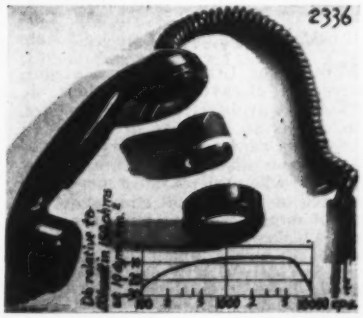


an array of miniature lamps lighted at 5 or 10-min. intervals by a W&T flasher motor mechanism which also drives a ventilating fan to draw sample of outside air; and one or two dry cell packs located outside housing.—*Wallace & Tiernan, 25 Main St., Belleville, N. J.*

For more information circle **390** on inquiry card.

Transistorized Microphone

New "Transluctance Microphone," available in handset (illustrated) or hand-held types, is said to combine advantages of magnetic and carbon microphones without their disadvan-

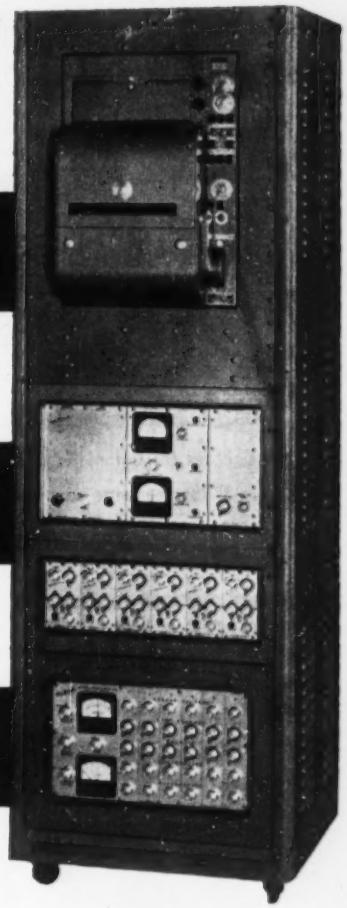


Heiland MULTI-(to 60) CHANNEL

RECORDING OSCILLOGRAPHS (Model 700)

AMPLIFIER SYSTEMS (Model 119)

BRIDGE BALANCE UNITS (Model 82-6)



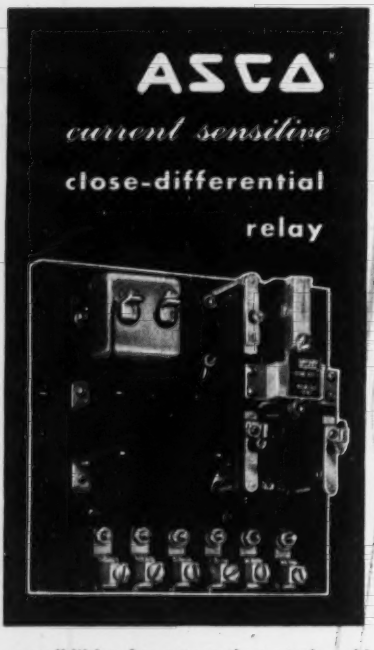
... *designed* for fixed or mobile relay rack mounting

Write for complete details on the instruments shown above, as well as Heiland galvanometers and portable recording oscillographs.

Heiland 20TH ANNIVERSARY

Heiland Research Corporation
130 East Fifth Avenue • Denver 9, Colorado

For more information circle **81** on inquiry card.



process control by motor current measurement

This Relay offers wide possibilities for automatic control problems. Why not investigate it for use with your process or equipment?

- **2% SENSITIVITY**
- **CONTINUOUS DROP-OUT ADJUSTMENT** —with factory-set pickup. (Also designed with a continuous pickup adjustment.)
- **SUPPLIED IN ANY POLE COMBINATION** —to 2 normally open, 2 normally closed.
- **OPEN OR ENCLOSED**
- **ELECTRICAL RATINGS**—Contacts rated 5 amps Continuous Current, 600 Volts Maximum; Coils to 60 Amp. Capacity—higher when supplied with current transformers.
- **VOLTAGE-TYPE AVAILABLE** —comparable construction and operating characteristics.
- **SPECIAL MODIFICATIONS**—high shock designs, variable pickup, frequency response, delayed action, etc.

Mixing a batch?

Assume you have a batch mixing process where the viscosity increases progressively as the batch nears completion. The current drawn by the driving motor will increase with the viscosity. An ASCO Close-Differential Relay could be used to automatically open the motor control circuit at the exact batch viscosity desired. This would be accomplished by merely calibrating relay operation to the current corresponding to desired viscosity.

In general, this ASCO Relay can provide a triggering impulse or trip in systems designed to control innumerable operations where electric motors are the power source or where current variations occur. Such systems include devices for the control of polymerization, measurement of viscosity, regulation of flow, etc.

when you can predict a current variable . . . consider an ASCO Close-Differential Relay for your automatic control.

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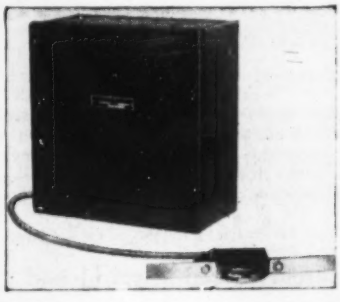

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Events...

August 2-13

University of Michigan program on Digital Computers at Ann Arbor and Willow Run Research Center. For information write Institutes Department, University Extension Service, University of Michigan, Ann Arbor, Mich.

August 2-13

Summer Session on Metallurgical Applications of X-Ray Diffraction at Massachusetts Institute of Technology. For information write Summer Session Office, Rm. 7-103, M.I.T., Cambridge 39, Mass.

August 25-27

Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif. For information write Russ Broman, Wescon, 344 N. La Boca Ave., Los Angeles, Calif.

Sept. 13-25

Instrument Society of America First International Instrument Congress and Exposition, Commercial Museum and Convention Hall, Phila. Contact Richard Rimbach, Mgr., 845 Ridge Ave., Pittsburgh 12, Pa.

September 17-18

Ninth Annual Calorimetry Conference at General Electric Research Laboratory. For information write James Stokley, General Electric Co., Schnectady 5, N. Y.

September 21-23

Annual Meeting and Exhibition, Society for Experimental Stress Analysis, Bellevue-Stratford Hotel, Philadelphia. For information write Mr. Frank G. Tatnall, P.O. Box 4034, Philadelphia 18.

September 29-30

Pittsburgh Conference on Industrial Electronics, sponsored by Professional Group on Industrial Electronics, Institute of Radio Engineers, at the Mellon Institute of Industrial Research, 4400 Fifth Ave., Pgh. 13, Pa. For information contact Dr. James Woodford, Carnegie Tech P. O., Pittsburgh 13, Pa.

October 1-5, 1954

Congres International de Chronométric, Paris. For information write R. Baillaud, Directeur de l'Observatoire National de Besancon, Besancon, France.

October 6-7

First Annual National Conference of the Institute of Radio Engineers Professional Group on Nuclear Science, Sherman Hotel, Chicago, Ill. For information write S. J. Goslovich, 517 Forest Ave., Glen Ellyn, Ill.

October 4-6

10th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. For information write R. E. Hornacek, c/o Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.

October 12-15

Eighth National Chemical Exposition, Chicago Coliseum, Ill. For information write Chicago Sec. of American Chemical Society, 86 E. Randolph St., Chicago 1, Ill.

November 29—December 2

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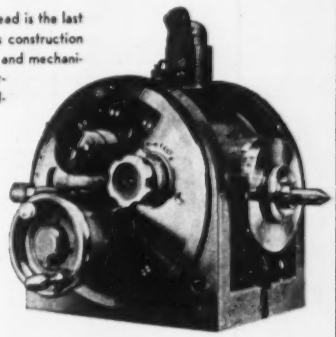

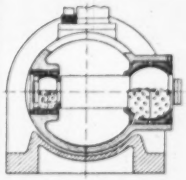

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Mercury-Thallium

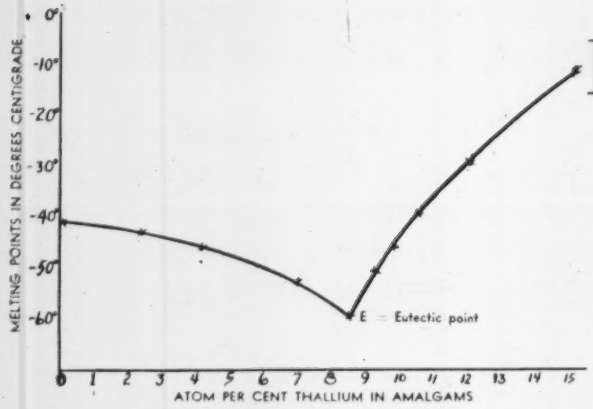

Fig. 1. Melting point vs. composition.

A eutectic mixture of mercury and thallium can be used for temperature measurement below the freezing point of mercury; calibration is not affected by long or repeated use, or by sudden transition in temperature.

CONVENIENCE and accuracy of mercury-in-glass thermometers are usually taken for granted. However, confront the user of thermometers with the problem of measuring temperatures below the freezing point of mercury (–38.89 deg. C.) and he becomes acutely aware of the merits of mercury. Thermometers filled with alcohol or other organic liquids of low freezing point are convenient but inaccurate; resistance thermometers are accurate but inconvenient.

Discovery of the element thallium by Crookes[25] in 1861 eventually led to the development of a successful thermometer for low temperature measurements. Thallium is a metal which resembles lead in its physical properties and in the poisonous nature of its compounds. Chemically, it resembles the alkali metals in its tendency to oxidize in air; other chemical properties show that it belongs to the aluminum group of metals.

Crookes reported, in 1863, that thallium readily forms alloys with mercury. Kornakow[12], in 1901, measured the freezing points of these alloys and showed that freezing points close to –60 deg. C. could be obtained.

Here, then, was a material which remained liquid at temperatures below the freezing point of mercury, but which otherwise resembled mercury in its physical properties. Charles Steinmetz was not long in seeing the possibilities; he filed application for a mercury-thallium thermometer in 1904; the patent was granted in 1910, and assigned to the General Electric Company. His patent was for a thermometer filled with an amalgam consisting of 10-percent thallium and 90-percent mercury. He claimed[24] that the thermometer could be used down to –60 deg. C. Two years later, McIntosh and Johnson[14] reported on the use of a thermometer filled with an 8.5-percent thallium and 91.5-percent mercury alloy which registered as low as –62 deg. C.

World War II provided the stimulus for the commercial production of accurate mercury-thallium thermometers. Research on lubricating oils in cold climates and at high altitudes required quick, accurate instruments for measuring low temperatures. In 1942 the Petroleum Refining Laboratory of Pennsylvania State College requested the H-B Instrument Company, Philadelphia, to make a few experimental models of mercury-thallium thermometers[7]. These experimental thermometers proved successful and commercial production ensued.

The manufacturing process is essentially the same as for mercury thermometers. The chief differences are (1) a thallium amalgam of the correct composition must be prepared and (2) the amalgam must be kept from contact with air at all stages of manufacture and storage to prevent oxidation. Elaborate procedures[18, 19] for preparation of the amalgam have been described.

Properties of a Eutectic Mixture of Mercury and Thallium

Composition and Freezing Point: The composition of the mercury-thallium alloy which has the lowest freezing point (the eutectic composition) is the one most suitable for low-temperature thermometers. Roos[20] measured the freezing points of amalgams containing various amounts of thallium. His results are shown in Fig. 1. The eutectic point in Fig. 1 represents an amalgam containing 8.56-percent thal-

TABLE 1. PROPERTIES OF MERCURY-THALLIUM EUTECTIC MIXTURE.

Property	*Conditions*	*Value*	*References*
PERCENT OF THALLIUM IN EUTECTIC MIXTURE	atom per cent* (percent by weight in this range is about 0.15% greater than atom percent)	8.34% 8.5 8.56 9.3	(12) (15) (13) (4) (17) (20) (10)
APPEARANCE		silvery liquid	
FREEZING POINT		–59°C. (–74°F.) –60°C. (–76°F.)	(20) (10) (12) (17) (15) (9)
DENSITY	g/c.c. at 0°C. g/c.c. at 20°C.	13.407 13.359	(17) (17)
COEFFICIENT OF EXPANSION	at 0°C. to 20°C. at all temperatures differential coefficient against Jena 16III glass at 0°C. to 20° C.	0.0001793 expands perfectly regularly 0.0001554	(17) (9) (14) (17)
SURFACE TENSION	dynes/cm. (at 18 C. for 9.09% Tl amalgam against air)	532	(1) (22)
CAPILLARY DEPRESSION		same as clean Hg	(17)
THERMAL CAPACITY	In mayers in cal./g.c. (mayers x 0.24)	0.1455 0.0349	(19) by calculation from (19)
FLUIDITY	at low temperatures	good	(17)
STABILITY	in presence of air in complete absence of air	oxidizes rapidly stable	(14) (14) (17)

*Formula for converting atom percent (a) into weight percent (w):
$W = (204.39a)/[204.39a + 200.61(100-a)]$

Thermometers

by JOSEPH EHRENREICH
Consultant, H-B Instrument Co.

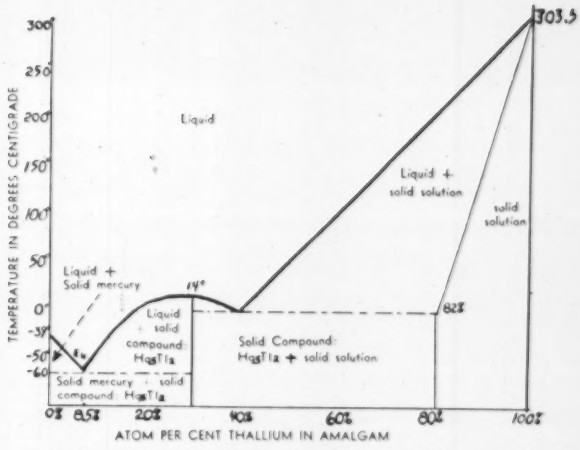

Fig. 2. Equilibrium diagram, showing state of thallium amalgams at various concentrations and temperatures. Eu is eutectic point.

lium and 91.44-percent mercury, which freezes at –59 deg. C. (These numbers represent *atom* percent; the *weight* percent is 8.7-percent thallium, 91.3-percent mercury. The formula for converting atom percent to weight percent is given in Table 1, footnote a).

Unfortunately, not all investigators are agreed on the exact eutectic composition and freezing point; Table 1 shows that the eutectic composition has variously been reported as 8.34, 8.5, 8.56 and 9.3 atom percent; and the freezing points as either –59 C. or –60 C. There have even been reports of mercury-thallium thermometers registering lower than –60 C. The presence of varying amounts of impurities would explain the varying results. Another possible source of error is the phenomenon of super-cooling, in which a liquid protected from mechanical disturbances fails to solidify at its theoretical freezing point. The writer inclines to accept the results of Roos because of the detailed nature of his research and because of his critical evaluation of the measurements made by the previous investigator in the field.

Comparison of Properties: A brief comparison of the properties of a eutectic mixture of thallium and mercury with the properties of other thermometric liquids is shown in Table 2. The liquids chosen for comparison are pure mercury, ethyl alcohol, and toluene. The latter two are taken as typical organic liquids used in thermometers.

Temperature Range: If low freezing point were the only consideration, organic liquids would be the liquids of choice for low-temperature measurements. Ethyl alcohol, for instance, freezes at –112 C., whereas mercury is solid below –38.87 C. Metals like sodium and potassium lower the freezing point of mercury by no more than 10 C. Of all mixtures of *metals* investigated, a thallium-mercury mixture had the lowest freezing point.[14]

Wetting of Glass: Organic liquids are unsuitable for accurate thermometry because they wet the glass capillary. Table 2 shows that ethyl alcohol and toluene have low surface tensions. Pure mercury, which does not wet glass, has a high surface tension. The surface tension of thallium amalgam (532 dynes/cm.) is close to that of mercury (487 dynes/cm.), and far greater than that of ethyl alcohol (22.3 dynes/cm.) and toluene (28.4 dynes/cm.) This similarity of mercury and thallium amalgam in respect to surface tension is reflected in a similarity in all surface properties. Thallium amalgam has the same capillary depression as mercury and, like mercury, does not wet glass.[1, 22]

Thermal Expansion: The coefficients of expansion* of thallium amalgam (0.0001793) and of mercury (0.000181) are similar; the coefficients of expansion of ethyl alcohol (0.0011) and of toluene (0.00109) are almost seven times greater.[17, 26] The organic liquids expand much more for a given temperature rise. This large expansion provides more opportunities for irregularities. Moeller[16] found that the expansion of organic liquids is uneven, being greater at some levels of temperature than at others. Of the various organic liquids tested, amyl benzoate had the most regular expansion. Thallium amalgam, on the other hand, expands regularly, as shown by the straight-line graph obtained in plotting temperatures using a thallium-amalgam thermometer against those given by a platinum-resistance thermometer.[14]

Thermal Capacity and Lag: Total heat capacity equals thermal capacity in cal./gm. times density in gm./cc. Table 2 shows that thallium amalgam, like mercury, has a low thermal capacity but a high density; organic liquids

TABLE 2. COMPARISON OF THERMOMETRIC LIQUIDS*

Property	*Thallium-mercury (approx. 8.5% Tl 91.5% Hg)*	*Mercury*	*Ethyl Alcohol (anhydrous)*	*Toluene*
Density (g. per c.c. at 20 C.)	13.359	13.546	0.79	0.87
Freezing Point (C.)	–59	–38.87	–112	–95
Boiling Point (C.)	—	356.9	78.4	110.6
Coefficient of expansion (near 20 C.)	0.0001793	0.000181	0.0011	0.00109
Surface tension (dynes per cm.) (against air, near 15 to 20 C.)	532	487	22.3	28.4
Thermal Capacity (cal. per g. per C. deg.)	0.0349	0.0334	0.58	0.41
Thermal capacity X Density	0.47	0.45	0.46	0.36

*References 26, 10, 1, 17, and 19.

* In practical manufacture of quality thermometers, no dependence is placed on uniform expansion other than for subdividing between a sufficient number of carefully established temperature points. The main significance of uniform expansion is that fewer "points" are required. However, the tube bore is never perfect.

have high thermal capacity but low density. The product of thermal capacity and density comes to about the same value no matter which type of liquid is used. In so far as lag is concerned, one thermometric liquid is as good as another.[26]

Stability: The stability of thallium amalgam in the thermometer depends on the care that has been taken to exclude all contact with air. The gaseous filling above the amalgam in the thermometer should be a pure nitrogen completely free of oxygen; other oxygen-free gases, such as hydrogen, might be used.[7, 8] Properly prepared thallium-amalgam thermometers have shown no signs of oxidation even after long use.[7] On the other hand, organic liquids may deteriorate even under oxygen-free conditions because of polymerization (the chemical union of like molecules with each other).[26]

Effects of Deviation from Eutectic Composition

As there is some doubt as to the exact eutectic composition, and as even the greatest precautions cannot prevent slight oxidative changes in composition during manufacture, it is probable that thallium amalgams in actual thermometers are non-eutectic in some degree. A non-eutectic mixture by definition would have a higher freezing point, but would there be any other difference? The equilibrium diagram (Fig. 2) shows that differences can be expected. This diagram shows the state of matter of mercury-thallium mixtures at various concentrations and temperatures. (The extreme left-hand portion of Fig. 2 is shown on a larger scale in Fig. 1.)

Fig. 2 shows that a perfectly eutectic mixture is liquid above –60 C. and freezes at –60 C. into a solid compound. However, note what occurs if the mixture is not eutectic—a slight increase in thallium concentration causes the mixture to start freezing into a mixture of liquid amalgam plus some solid compound Hg_5Tl_2; a slight increase in thallium content causes the mixture to start freezing into a liquid amalgam plus some solid mercury. In both events there is a region of partial freezing. This can affect the thermometric behavior, cause local heating effects due to latent heats of fusion, and make the thermometer unreliable.

The NBS tested two amalgam thermometers over the range –53 to –60 C., with both falling and rising temperatures. Under the best conditions (rising conditions) the two thermometers were unreliable below –57 C. The erratic behavior may have been caused by the freezing of one of the components.

Erratic behavior at other temperatures may be explained by impurities in the amalgam. These impurities may be present in the thallium, mercury, and nitrogen as supplied to the thermometer maker, or they may arise through oxidation or contamination during the manufacturing process.

Characteristics of Mercury-Thallium Thermometers

Specifications: A thallium-amalgam thermometer resembles an ordinary mercury thermometer, but the extension downward of the temperature range imposes certain small differences in construction. These differences vary with the use for which the thermometer is intended.

Precautions in Use of Thermometer: When the thermometer is removed from the bath and laid down on the table with a slight jar, a small globule of amalgam may separate from the main body of the liquid in the expansion chamber and remain in the expansion chamber when next cooled.[7] However, the liquid seems to be easier to reunite than in the case of straight mercury thermometers.[11] It is advisable to attach a tag to the thermometer reading: "Examine top chamber with magnifying glass for separate globules, and reunite before using."[8]

Theoretically, if the thermometer has been heated to 212 F., a period of 72 hours should elapse before it is used for low-temperature measurements; a quick cooling would bring about a maximum ice-point depression and a change in all readings. However, two thermometers were checked for ice-point; the freezing-point depression proved to be only 0.02 F., a negligible variation. Table 3 gives additional evidence that there need be no concern about the effect of preceding temperatures on the accuracy of mercury-thallium thermometers. Occasionally a "dud" is encountered among these thermometers, presumably due to faulty manufacture.

Test of Thermometers: Of eleven thermometers tested, four actually gave readings which coincided exactly with reading of the resistance thermometer throughout the range –70 F. to 70 F.; and four others had maximum deviations of 0.1 F. The only thermometer seriously in error was thermometer "K," an experimental model for registering maximum temperature.

TABLE 3. CORRECTIONS FOR MERCURY-THALLIUM THERMOMETERS

Thermometer	*Correction*			
	at –30.00°F.	*at* –30.00°F. *one week later*	*at* –40.00°F.	*at* –40.00°F. *one week later*
M	0.10	0.10	0.10	0.10
N	–0.25	–0.25	–0.35	–0.30
O	0.15	0.10	–0.25	–0.20
P	0.10	0.10	0.15	0.10
Q	—	—	0.10	0.10
R	—	—	—	—

Acknowledgment

Review of this paper by Mr. R. C. Jacobsen is hereby acknowledged.

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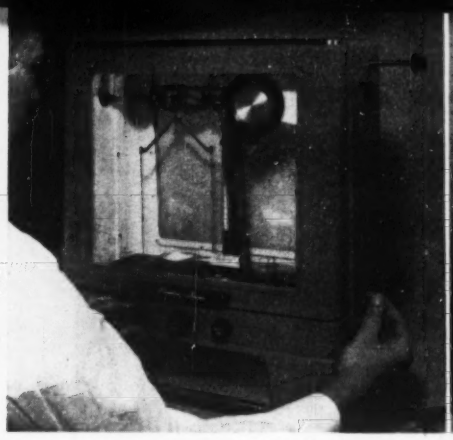

Fig. 1. Direct weighing.

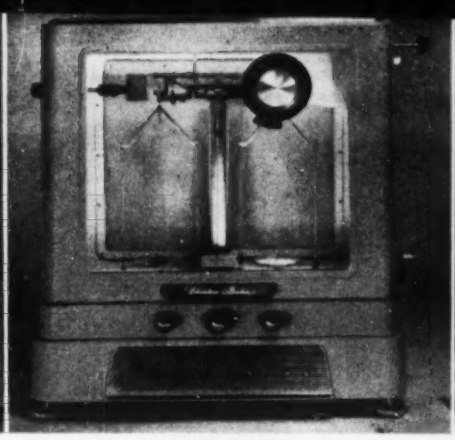

Fig. 2. Substitution weighing, first step.

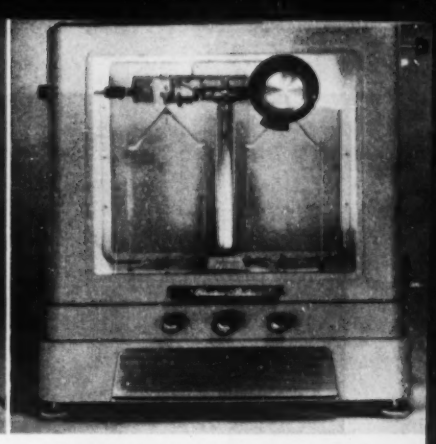

Fig. 3. Substitution weighing, second step.

Weighing Techniques With ANALYTICAL BALANCES

by FRANK O. DEIMEL
Christian Becker Div.,
The Torsion Balance Co.

WEIGHT MEASUREMENTS can be made to high accuracy with an analytical balance by one of several methods of weighing. Operating conditions determine which weighing method is most advantageous; the laboratory technician should consider the performance of his balance, his ability in using the balance, and the type of work to be done. The two general methods of weighing comprise zero methods and deflection methods.

Zero Methods

A zero method is one in which a weight, rider, chain or other balancing device is adjusted until the rest point is the same as the zero reading. The term "zero" usually means the center of the index scale. The "zero point" of an unloaded balance is the mean of the swings in each direction. "Rest point" and "equilibrium position" are synonymous and, in theory, should be at the zero on the index. Two common zero methods of weighing are (1) simple direct weighing and (2) simple substitution weighing.

Simple Direct Weighing

The first step in this method is to determine the zero point. Then the sample to be weighed is placed on the left pan and weights are put on the right pan. The rider, chain, or other weighing accessories are adjusted until the rest position is the same as the zero point (Fig. 1). The weight of the sample is the total of weights plus the amount of chain or rider adjustments.

If weighings are infrequent, check the zero point before each weighing. For frequent weighings, check the zero point periodically.

Simple Substitution Weighing

The simple substitution weighing method is an extremely accurate method, but it requires more time than the direct-weighing technique.

In this method it is not necessary to determine the zero point. The first step is to approximately counterbalance the sample with weights or taring material; the rest point is noted (Fig. 2). The sample is then removed and the *previous equilibrium position* is restored by adding weights and adjusting rider or chain (Fig. 3). Total weight of the material is the sum of weights plus rider and chain values.

Deflection Methods

In deflection weighing the departure from the zero reading is used to determine a part of the recorded weight of the material.

Single-deflection Weighing (Single-swing Readings)

An overload is given to the balance by adjusting the beam star wheel or equilibrium point so that releasing the balance causes the pointer to swing three to seven divisions from zero. Note this first turning point. Repeat the procedure several times to assure reproducibility. Make sure pan arrests do not cause lateral vibration of pans when balance is released because this affects reproducibility. To weigh, put sample on left pan. Adjust weights until pointer turns at the first turning point. The weight of the material is the sum of the weights plus rider and chain values used to reproduce this first turning point.

Chief advantage of this method is rapid weighing. However, because it permits rapidity, extreme caution should be taken against carelessness in any of the steps. Before using this method it is recommended that the operator check it against others to determine its relative accuracy and speed.

Estimating Final Fraction

In all weighing, a final small portion of the weight may be computed from the difference between final rest point and zero point without adjusting the rider, chain, or other devices to have the pointer rest at zero.

The following equation gives the weight equivalent of this difference: $Weight\ Equivalent = (R\text{-}Z)/X$, where R is the final equilibrium position, Z the zero point, and X the change in rest point of the balance caused by 1 mg. change in weight. As X may vary with the load on the pans it should be determined for various loads.

The direction of this difference from zero determines whether the weight equivalent should be added to or subtracted from the reading. When using this method in analytical work the readings are usually taken to the nearest milligram; tenths of a milligram are then calculated.

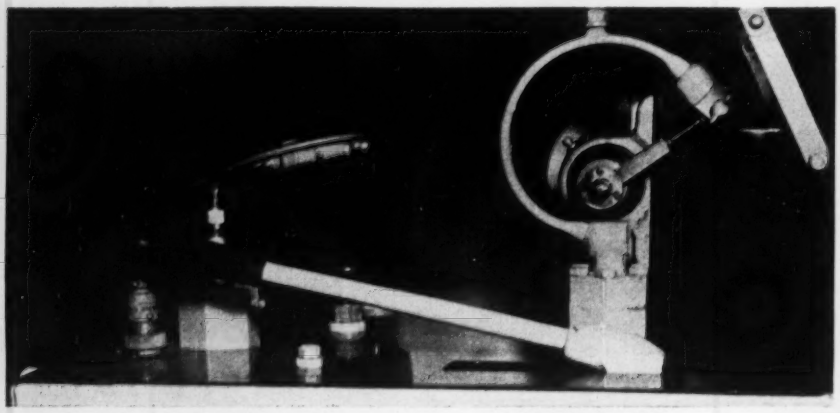

Fig. 1. Static-pressure pump and pulse-generating Bourdon tube.

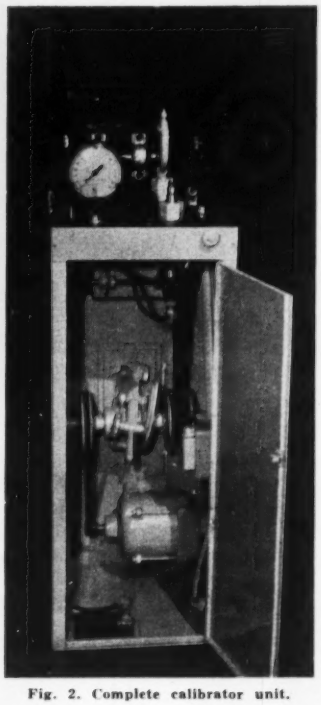

Fig. 2. Complete calibrator unit.

by RAYMOND C. BAIRD, ROBERT L. SOLNICK, and JAMES R. AMISS
The Fluor Corporation

Calibrator for

Dynamic Pressure Transducers*

RESEARCH LABORATORY with which the writers are associated has maintained a mobile laboratory for making field measurements[1, 2]. One of the most important of these measurements concerns dynamic pressure conditions in high-pressure pipelines[3]. Electronic techniques involving different types of pressure transducers are employed. The most rugged and reliable type of transducer has been found to be the magnetostrictive variety, such as developed for use in fuel-detonation research.

Fig. 3 shows a magnetostrictive-type pressure transducer. The core of magnetostrictive material, around which the induction coil is wound, is put under compression during manufacture and maintained in that condition by the diaphragm. Variation in gas pressure varies the length of the core, causing an electromotive force proportional to the *rate of change* of the length of the core to appear at the terminals of the winding.

Owing to the dynamic action of the magnetostrictive transducer, whereby the induced emf. is proportional to the rate of change of pressure, it cannot be calibrated unless a varying pressure of precisely known characteristics is provided. On the other hand, a strain-gage transducer, operating with either carrier or d-c. electronic equipment, can be calibrated statically. If a strain-gage unit is exposed to the same pressure variation as a magnetostrictive-type transducer, a direct comparison between the outputs of the two can be made and calibration effected using the strain-gage unit as the standard reference. (The magnetostrictive output is, of course, electronically integrated before comparison.) The remaining requirement is to provide the sinusoidal pressure variation of controllable amplitude and frequency for the range of calibration desired.

New Calibration Technique

It was decided that a hydraulic system might offer advantages if a means could be devised for producing sinusoidal pressure variations having the amplitude and frequency range desired. After observing the needle action of pressure gages affected by pulsative gas-flow, it was thought that the Bourdon-tube element might be operated in reverse in a hydraulic system to obtain the desired effect. Furthermore, because of its relatively low mass and great durability, it might be possible to obtain a wide range of pulse frequencies. Experiments substantiated the idea and a unit was constructed for the mobile laboratory (Figs. 1 and 2).

The mechanical design of the pulser was aimed at transforming the rotary motion of a prime mover to a sinusoidal motion of adjustable frequency and amplitude. A J.F.S. variable speed control, with three sets of pulleys, provides a frequency range of 0.75 to 30 cycles per second. Conversion of the rotary motion to a sinusoidal one is accomplished by using an eccentric crank-arm arrangement, as shown in Figs. 1 and 4. An adjustable amplitude is obtained by coupling the crank arm to a pin mounted non-concentrically on a cylinder, the cylinder itself being off the driveshaft centerline.

Sinusoidal Pressure Wave

Transformation of the mechanical motion to a sinusoidal pressure wave is accomplished by a Bourdon tube filled with a hydraulic fluid. Reciprocal motion of the free end

*This article is an abstract of the original paper, which also describes other calibration techniques.

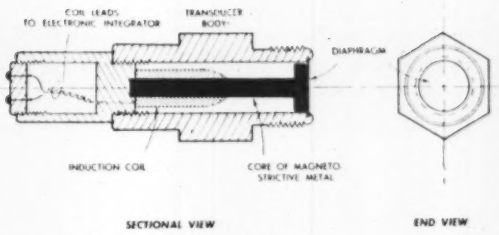

Fig. 3. Magnetrostrictive pressure transducer.

of the tube causes a sinusoidal pressure wave to be produced in the fluid. The pressure is transmitted to the diaphragms of both the standardized transducer and the transducer being calibrated; the transducers are mounted "back-to-back" in a common steel coupling (Fig. 4).

A 5000-psi. hand-operated pump produces any desired static pressure in the system from zero to 5000 psi. The static pressure is indicated on a laboratory-type pressure gage.

Operation

With the calibrator operating to furnish the desired wave amplitude and frequency at a given static pressure, the outputs of both the standardized transducer (strain-gage) and the magnetostrictive transducer being calibrated are fed to their respective electronic amplifiers which, in turn, drive oscillograph pens recording simultaneously on a single chart (Fig. 5). As the output of the magnetostrictive transducer is proportional to the derivative, or the rate of change of pressure, an electronic integrator is used to convert the output to a signal proportional to pressure. The strain-gage transducer output goes directly to a carrier amplifier.

Response Characteristics

Calibration data for magnetostrictive transducers are normally obtained for at least three pulse-pressure amplitudes at each of three static pressures (50, 250, and 1000 psi.). Pulse amplitudes between 0 and 90 psi. can be obtained, the upper limit depending on the static pressure. Pulse amplitude is determined mainly by the degree of eccentricity set into the rotating eccentric pin, the static pressure, the volume of fluid in the system, and fluid characteristics.

Sensitivity as a Function of Static Pressure

The over-all sensitivity of particular magnetostrictive type transducer is a function of the static pressure, although the general shape of the curve with respect to frequency does not change with this parameter. This is illustrated in Fig. 6. It was also found that the effect of static pressure is rarely the same for different transducers.

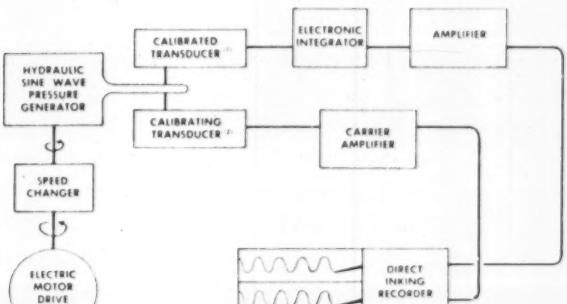

Fig. 5. Block diagram of operating system.

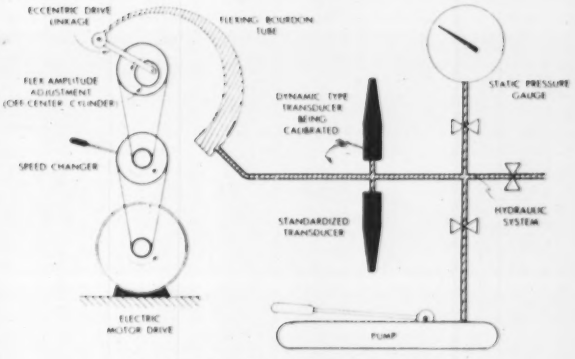

Fig. 4. Schematic of dynamic calibrator.

Sensitivity as a Function of Frequency

The output of the particular variety of magnetostrictive transducer tested was found to be variable with frequency. The maximum sensitivity was found to occur at about 3 to 4 cps. The sensitivity versus frequency curves (Fig. 6) tend to be parallel over a wide range of static pressure.

Sensitivity as a Function of Amplitude

It has been found that for a given static pressure, a change in wave amplitude results in a change in sensitivity of the transducers, spreading the calibration curves at particular static pressures and frequencies. However, as the extent of this spreading is small compared with inherent inaccuracies from other sources, this amplitude effect does not appear in Fig. 6.

It should be mentioned that in the preparation of curves, corrections must be made for nonlinearities introduced by the electronic or electromechanical oscillographic equipment. The curves of Fig. 6 emphasize the necessity for individual calibration of transducers as a function of static pressure, pulse-wave amplitude, and pulse-wave frequency.

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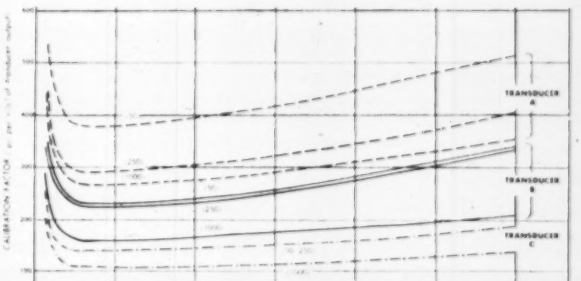

Fig. 6. Calibration curves of typical transducers.

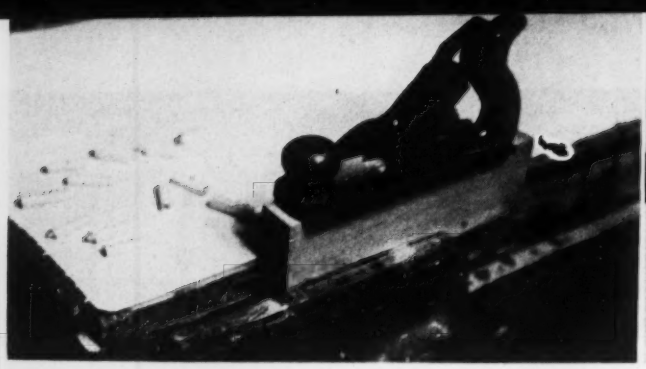

Fig. 1. Shaving the wood elements from a block of wood. The carpenter's plane forms the shavings into a curl ready for winding into a cylinder.

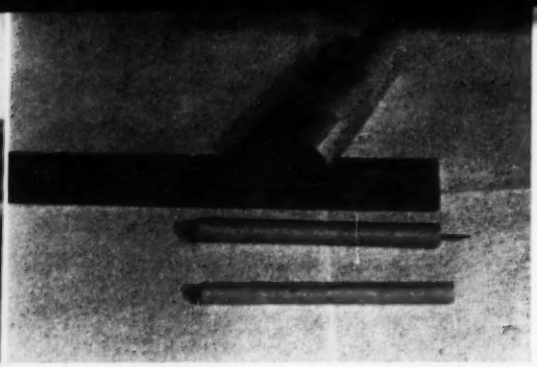

Fig. 2. Completed moisture-sensitive elements. Top—large convolute type; middle—spiral type; bottom—small convolute type.

New Moisture-sensitive Element for RELATIVE HUMIDITY

by JAMES W. CASE*

THE NAVY decommissioned many ships after World War II but kept them in readiness by "moth-balling." The air in the ships was dehumidified to a relative humidity at which machinery would not rust (30-percent relative humidity or less) by using drying agents such as silica gel and activated alumina. The process required continued surveillance of the moisture condition; the instruments used—hygrostats, humidity recorders, and hygrometers—had human-hair sensitive elements because these have been a preferred type for years.

The Navy purchased large quantities of the human-hair-type instruments without any procurement specification. Experience with these instruments brought out their shortcomings—the frailty of the human-hair element and its gradually increased error toward higher humidity. These failings resulted in a study of all principal types of hygrometers on the market and an attempt at an adequate specification for high-quality instruments. This study revealed that few materials are reliable moisture-sensitive elements, and challenged the origination of a new type despite the fact that the scientists have investigated every hygroscopic material from plant fiber to plastics.[1, 2]

Wood Element

A number of patents have been issued covering wood elements. Wood can be made to work as a moisture-sensitive element provided that a reliable wood is selected and that the element geometry is arranged for best usage of the moisture-distortion characteristics. This article reports a wood-shaving-type element invented by the author.

The familiar shrinking of wood in drying out has been investigated by the Forest Products Laboratory[3, 4] of the Department of Agriculture. This authority has this to say: "Wood shrinks most in the direction of the annual growth rings (tangentially), about half as much across these rings (radially) and very little, as a rule, along the grain."

Consideration of Forest Products data led to the conclusion that the radial shrinkage is the most practical characteristic to use because a radial plane in a tree log presents a wide area from which to select a uniform moisture-sensitive membrane, whereas tangential shrinkage, although greater, is in a plane only tangent to the growth rings. The membrane should be thin for rapid response.

At the sacrifice of magnitude of distortion, a soft wood (eastern white pine) was selected for investigation because of its workability. From a block of uniformly grained pine that had been air seasoned for ten years, shavings in thickness from 0.035 to 0.005 inch were produced with a sharp carpenter's plane (Fig. 1). These shavings were assembled into cylinders (Fig 2).

Types of Cylinders

Two types of elements were developed (Fig. 2):

1. *Convolute Type.* In this type the wood shaving is wound convolutely on a mandrel of the desired size to produce a tube having the grain of the wood running perpendicularly to the tube axis. This tube then expands or contracts along its axis with moisture changes of the air. It has been found that elements of ½-in. diameter and 5-in. length have sufficient movement and power to operate direct-reading humidity indicators.

2. *Spiral Type.* In this type the wood shaving is wound spirally on a mandrel with the wood grain running at a pitch to the axis of the tube. This construction gives an angular shift between the ends of the tube with changes of atmospheric moisture; a shaft extension of the element may be directly connected to the instrument pointer without any intervening multipliers, pulleys, cams, gears, etc.

Three hygrometers with convolute- and spiral-type elements are illustrated in Fig. 3.

Performance Tests

Scale Marking

Three test chambers were constructed of sheet glass and maintained at standard relative humidities by means of saturated salt solutions as recommended by the Bureau of Standards.[1] These are given in Tabie 1.

TABLE 1.—STANDARD RELATIVE HUMIDITIES

Relative Humidity	*Salt*
32%	$MgCl_2 \cdot 6H_2O$
52%	$Mg(NO_3)_2 \cdot 6H_2O$
75%	NaCl

The instruments were held in the test chambers for sufficient time for the readings to stabilize; scale markings at these points formed the basis for their permanent scales. It was found that there was close agreement between

*Head, Materials Section; Plastics Preservation and Materials Handling Branch; Bureau of Ordnance, Department of the Navy.

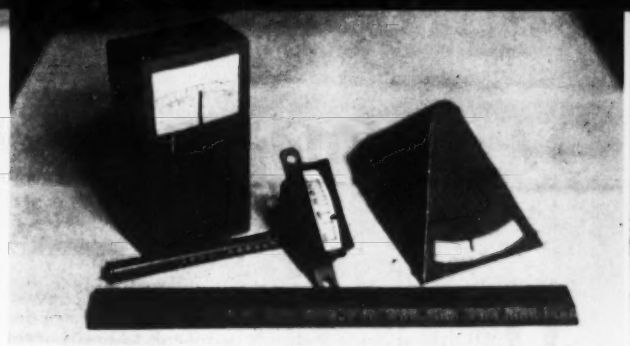

Fig. 3. Completed hygrometers. From right to left: Instrument C-5 with spiral-type element; Instrument C-6 with spiral-type element; Instrument C-8 using convolute-type element.

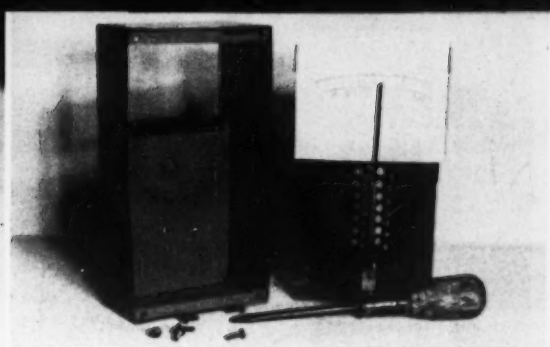

Fig. 4. Inside view of instrument C-8, showing sensitive-element mounting.

Moisture-sensitive elements of white-pine shavings prove to be comparable to hair-type elements in accuracy, stability, and response rate. Possibilities for new uses as well as redesign and improvement of humidity instruments are suggested.

these points and complete scales which were calculated from the known shrinkage characteristics of a given wood (calculated from Forest Products Data[2, 3]).

Calibration Tests

Following the inscription of the scales, wood-element and hair-element instruments were calibrated at the three known relative humidities and the following instrument errors were recorded:

TABLE 2.—INITIAL INSTRUMENT ERRORS

Relative Humidity	*Spiral Wood Element*	*Convolute Wood Element*	*Hair Element*
32%	+2	+1	+5
52%	0	0	0
75%	+1	+1	0

Outdoor Exposure Test

The wood and hair-type instruments were placed in a screened cabinet on an open porch at ground level, facing north at a location 20 miles from Washington, D.C., and exposed for a full year (from January, 1951, to January, 1952).

At the end of the year exposure period the instruments were taken back to the laboratory and *without any changes whatever in the instrument scale settings from the original calibration* they were recalibrated in the test chambers using fresh salt solutions. It was found that the severe weather cycling over one year had caused negative scale errors in all three instruments:

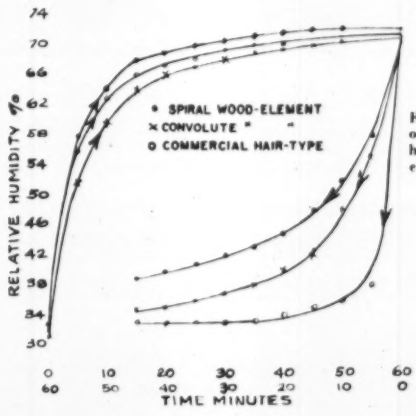

Fig. 5. Response rate of wood-element and hair-type hygrometers.

TABLE 3.—ACCUMULATED ERRORS AFTER ONE YEAR

Relative Humidity	*Spiral Wood Element*	*Convolute Wood Element*	*Hair Element*
32%	−2	−9	−5
52%	−2	−12	−2
75%	−1	−11	−4

Rate-of-Change Test

The rate at which an instrument responds is of primary interest. Hygrometers are characteristically slow in response and are also subject to considerable lag.

A rate of change test was made on the two wood elements, together with the hair-type element. All three instruments were permitted to stabilize in the 32-percent RH chamber and then were moved to the 75-percent RH chamber. Five-minute simultaneous readings were then taken on all three instruments until their readings leveled off. Following this, the instruments were moved back to the 32-percent RH chamber and the rate curves for the down cycle were determined similarly.

Fig. 5 is the result of these tests. Note that on the up cycle, the rate curve of the hair-type instrument lies between those of the two wood-element instruments. However, on the down cycle, the hair-type instrument is much the fastest of the three instruments. The lag values of the three instruments are less on the up cycle than on the down; however, the curves show that at least one hour is required for both the commercial hair-element instrument and the wood-element instruments to stabilize with a humidity change from 32 to 75 percent.

In conclusion, it is believed that the demonstrated unique cross-grain moisture-sensitive deformation of wood shavings, arranged in tubular form, holds high promise as the moving force in hygrometers, hygrostats, hygrographs etc., where hair-type elements are commonly employed. Possibilities for redesign and improvement of such instruments, and also the adaptation of the principle to new uses are suggested.

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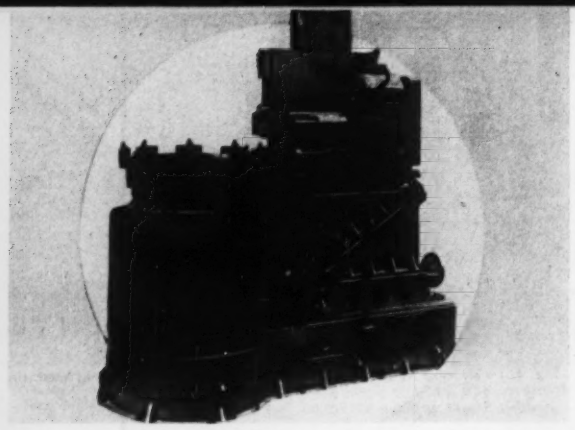

Fig. 1. Machine to which the checking principle was applied.

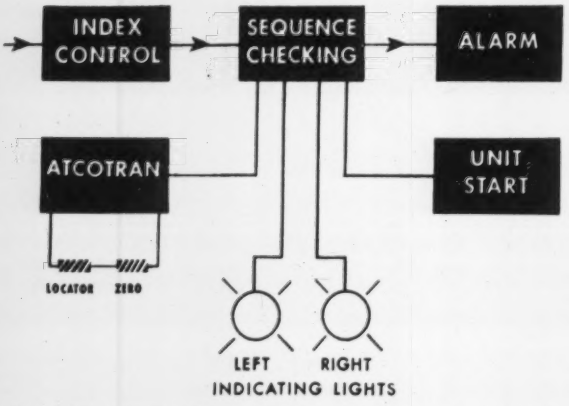

Fig. 2. Block diagram of the checking circuit, showing major components.

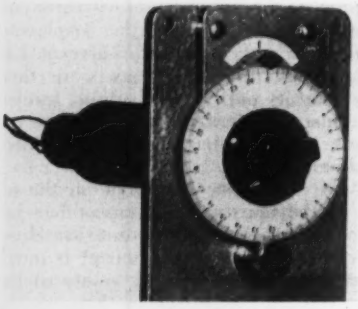

Fig. 3. The zeroing differential coil used to change the null position.

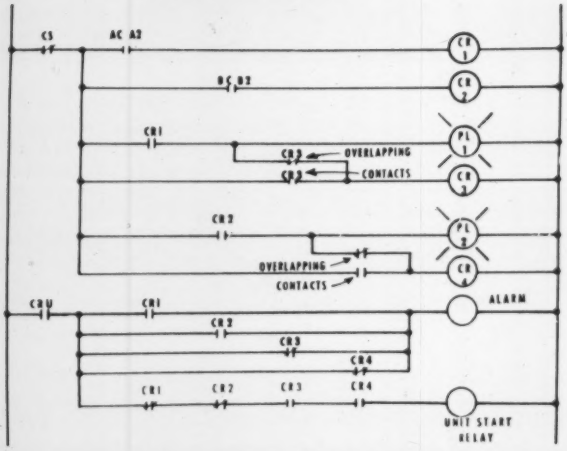

Fig. 4. Circuit diagram of the sequence checker.

ON the periphery of a jet-engine shroud there are over 80 drilled holes. Hence it is difficult to position this piece in so many stations accurately; it is even more difficult to determine if the piece is properly positioned prior to machining, particularly to 0.001-inch tolerance. This problem was brought to Avey Drilling about two years ago.

The unit for checking positions had to be sensitive, rugged, dependable, simple to adjust, and easy to maintain. Also, it was to indicate position by relay contacts and was to have a reasonable price.

Systems Tried

The first system tried was a photoelectric system having a sensitivity of a few microinches. Light from a 100-watt projection lamp focused in an area of 0.25 square-inch, and a photomultiplier tube with a potential of 1250 volts applied to it comprised the set up. With any reduction of these conditions, the sensitivity fell off so rapidly that it was never possible to make a practical device using these components.

Several other devices were investigated and some solutions were found that would perform satisfactorily, but always fell down on one of the other requirements. One company quoted $17,000 for equipment to check four positions, and our first application required checking at 88 positions.

Final System

The final system not only permits checking positions but also can be made to measure deviation. The heart of the system is an "Atcotran" differential transformer.

The indexing movement of the machine to which the system was to be applied carried past the point of location several thousandths, and then slowly reversed to the final position. This permitted the design of a circuit which not only checks location but also forces the "Atcotran" to prove that the circuit is functioning properly.

A block diagram of the checking circuit is shown in Fig. 2. The index control and the "Atcotran" operate contacts in the sequence checker; the indicating lights show whether the part is to the left or right of the desired position. When the indexing has been completed, the sequence checker instantly energizes either the unit starting circuit or the alarm circuit.

To avoid having to make fine mechanical adjustments of the locating coil, a remotely located zeroing differential coil (Fig. 3) is used. When properly connected in series with the locator, it produces a bucking voltage which can be adjusted to move the null point 0.025 inch per turn of the zeroing knob.

The circuit of the sequence checker is shown in Fig. 4. Contact CRU at the bottom of the circuit is not closed until the index is complete. At the start of the cycle, contact CS in the upper left part of the diagram is opened during the rapid advance of the table, to release the checking circuits. When the table drops to low positioning speed, CS is closed. Contact AC-A2 in the "Atcotran" is closed while the table is approaching the null point; this operates CR3,

Presented at the 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corporation, at Buffalo, N. Y., April 6 and 7, 1954.

POSITION GAGING

by HARLAN E. GRIMES
The Avey Drilling Company

A differential-transformer position detector is the heart of a versatile, rugged, and economic device for automatic position gaging of work pieces in a multi-station machine.

which in turn holds through overlapping contacts. Upon passing through the null point, AC-A2 is opened, releasing CR1, and contact BC-B2 closes. This operates CR4, which holds through overlapping contacts. The table reverses to the null point, releasing BC-B2 and CR2; CRU contact then closes. If the sequence has been correct and complete, the circuit to the alarm will be open, and the unit start relay will operate. Any fault in the sequence or the final position of the table will energize the alarm circuit, meanwhile preventing the unit start relay from operating.

The control relay used (Fig. 5) was a Class 6182. The sensitivity can be adjusted to detect a null position of the differential armature with a tolerance of 0.0001 inch. There are two single-pole, double-throw relays, operating on opposite sides of the null point. There are two bias controls, a sensitivity control, and a selector switch for checking and adjusting the unit. Except for a ring-type selenium phase detector and two d-c. amplifier stages, the circuit is similar to an audio amplifier. As the differential coil has low impedance, stray electrostatic pickup is minimized. A new superseding relay is shown in Fig. 6.

The differential transformer with armature is shown in Fig 7. It is mounted on a block-type clamp of Micarta.

Fig. 7. Class 6204-A differential transformer with armature.

The armature is moved through the coil in a straight line motion; it, in turn, is operated by a linkage which contacts the point to be checked.

The panel with the Atcotran mounted in the lower right corner is shown in Fig. 8.

A machine in which this checking device was used is shown in Fig. 1. It milled an irregular pattern of 17 holes in the flange of a jet-engine shroud. The box in the center of the picture contained the zero adjuster.

As this equipment can measure deviation and also excess of tolerance by relay contacts, it can be used for automatic readjustment of tooling. The exact circuits and mechanical devices to be used could vary widely, so no attempt will be made to describe such a system.

The cost of the electronic checker, differential coil, and zero adjuster was about $240, an insignificant sum compared to the $10,000 cost of this particular jet-engine part.

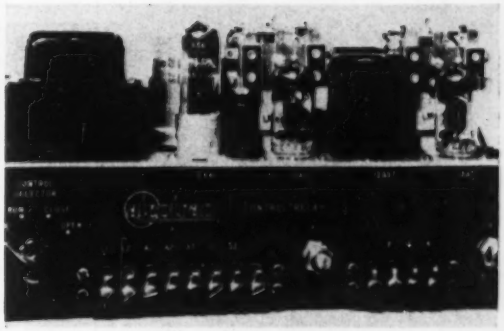

Fig. 5. Class 6182 control relay.

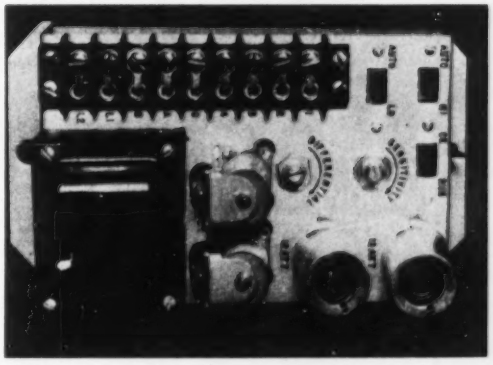

Fig. 6. Top view of later model relay.

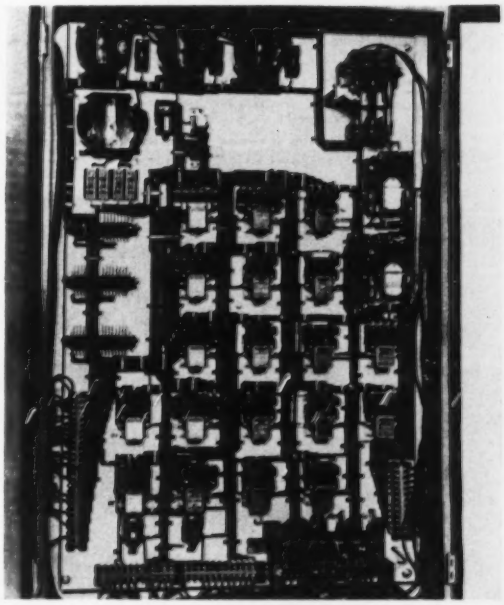

Fig. 8. Panel with "Atcotran" mounted in lower right corner.

AUTOMATED LATHES

by R. J. PECK
Seneca Falls Machine Company

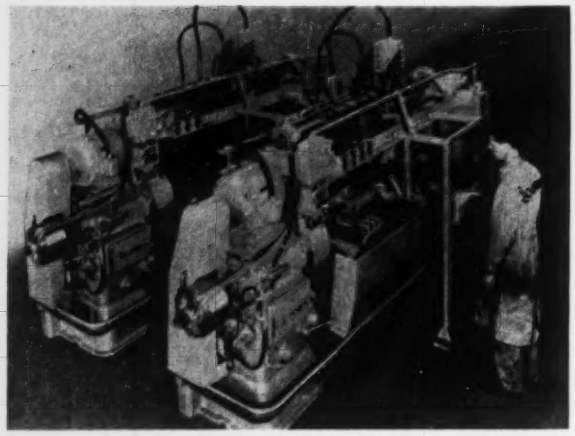

Fig. 1. Automatic camshaft-machining set-up consisting principally of "LR Lo-Swing" automatic lathes, conveyors, and gages.

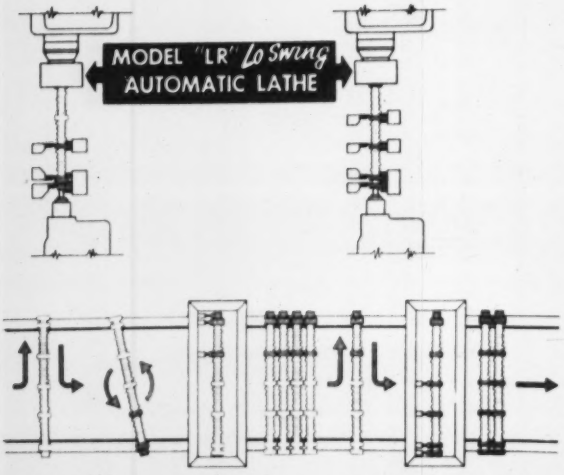

Fig. 2. Flow diagram showing progress of camshaft through machining process.

AUTOMATING A LATHE has its problems. As the work must be moved during the machining process, it cannot be simply clamped in place and left there while the tool moves. The tools also move during a turning operation. This combination helps to introduce the problem of accessibility for the work piece. It cannot be moved laterally through the machine as in most automated set-ups. It must be brought in and removed, probably by the same route, certainly from overhead. The Seneca Falls "LR Lo-Swing" automatic lathe uses a trolley-type work-transfer mechanism that can handle finished and rough parts simultaneously.

A pair of these lathes were recently teamed with automatic gaging and a conveyor system to form fully automatic facilities for turning the bearing surfaces on camshafts at a high production rate. These two lathes (Fig. 1) can machine and gage 112 camshafts per hour. Together, they turn, square, and chamfer seven diameters on each piece.

The progress of a camshaft through the machine can be traced in Fig. 2. The work-transfer carrier loads the rough camshaft from the incoming conveyor into the lathe, simultaneously removing the semi-finished part on which three diameters have just been turned, squared, and chamfered. The semi-finished part is deposited by the transfer carrier into a turn-around cradle which turns the piece end-for-end. The three diameters are then gaged and, if in tolerance, are transferred to the next lathe where the operation is essentially repeated—except that four diameters are turned, squared, and chamfered. Total machining time in each lathe is 0.313 minute; the total time spent by a part in each machine is 0.533 minute. This progression can be followed more closely by examining each operation.

Presented at the 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corporation, at Buffalo, New York, April 6 & 7, 1954.

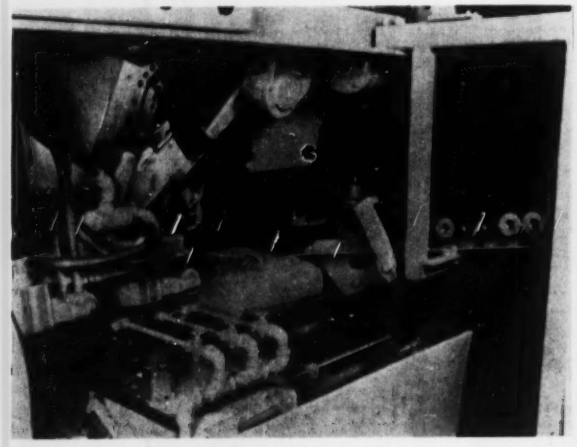

Fig. 3. Trolley in loading position.

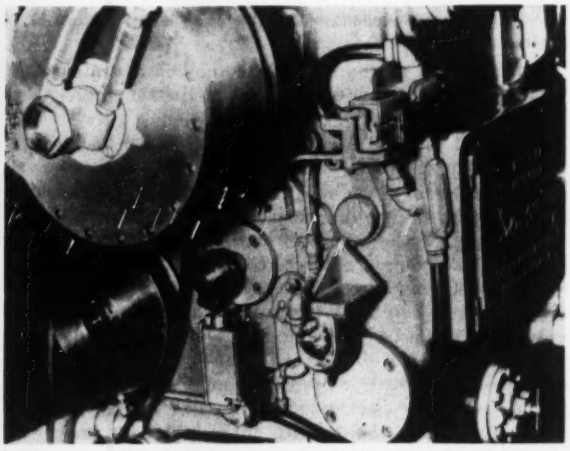

Fig. 4. The two controlling limit switches.

Automating a lathe requires automatic work transfer, automatic gaging, and flexible tool arrangement; results include reduced costs and increased quality of work.

The transfer carriers are equipped with loader slides, which in turn have air-operated fingers for grasping work pieces. Thus the carrier moves laterally, the loader slides move vertically, and the fingers provide the holding media. The trolley is shown in the loading position in Fig. 3. A rough piece, ready for machining is held in the fingers. In operation, the rear leader-slides descend first and pick up the completed part; the front slides then descend and place the rough part in the machining position, where it is picked up by the tail stock center.

When a part is transferred into the lathe, one of two limit switches, Fig. 4, acts to shift control from the machine to the transfer carrier. The first of these switches is actuated at the end of the machining cycle to release the spindle clutch, stopping spindle rotation. This switch also energizes a stepping relay which sets up the cycle of operation for the transfer loader equipment. The end of the loading cycle is signalled by the closing of the chuck jaws on work piece. At that time, a second limit switch is actuated which engages the main drive clutch, starting spindle rotation and the machining phase of the cycle.

Automatic Gaging

When the semi-finished piece has gone through the turn-around operation subsequent to first-lathe machining (Fig. 5) it is deposited on an air-operated elevator. This elevator raises it into the gaging station (Fig. 6).

The electric gages in the gaging stations (three in the first, four in the second) indicate, by means of colored lights on a control panel (Fig. 7) whether the parts are oversize, undersize, or intolerance. When all diameters inspected are within the specified tolerance, the work piece is automatically released from the gaging station. If the piece is out-of-tolerance, it remains in the gaging station, and the machine which has produced it is automatically shut down at the end of the machining cycle then in progress. After a change of tools, as indicated by the gaging control panel, a master control button will return the lathe to automatic.

Each lathe has complete flexibility in control; it can run independently or as a unit, on automatic or manual control. Flexibility in production has also been designed into the machine by providing conveyor banks ahead of each automatic lathe; a bank of camshafts can be stored, permitting operation for a time regardless of the condition of the immediately proceeding process. It also permits tool changes and adjustments to be made on either lathe while the other continues in operation.

Tools are designed for easy replacement. Front turning tools are fitted with adjusting screws which are preset in the tool room after the tools have been ground. Preset rear facing and chamfering tools are mounted in magazine-type tool blocks which are replaced quickly by other magazine blocks. Consequently, no tool setting is required at the machine for any of the tools.

All controls and actuating devices are either mechanical, electrical, or compressed air. Hydraulic controls and electronic components are not used. Fig. 8 shows the electrical control panel for one of the lathes. The main components here are the circuit breaker, dry-type selenium rectifier, multi-pole relays, and stepping relays.

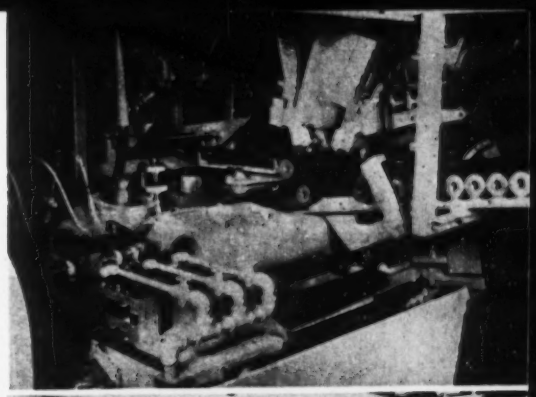

Fig. 5. Semi-finished part on turn-around bracket.

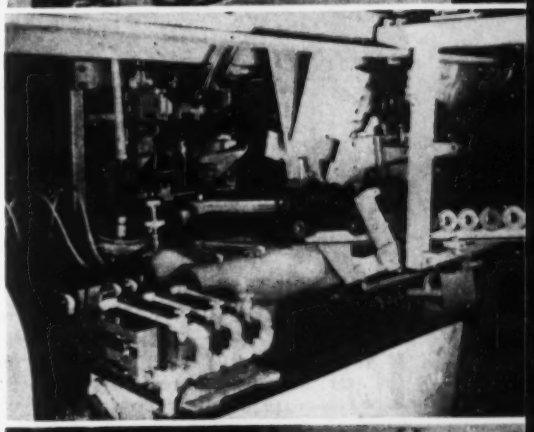

Fig. 6. Part in gaging station.

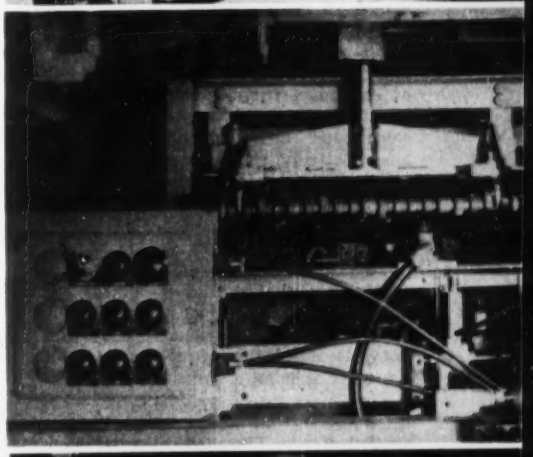

Fig. 7. Gaging-station control panel.

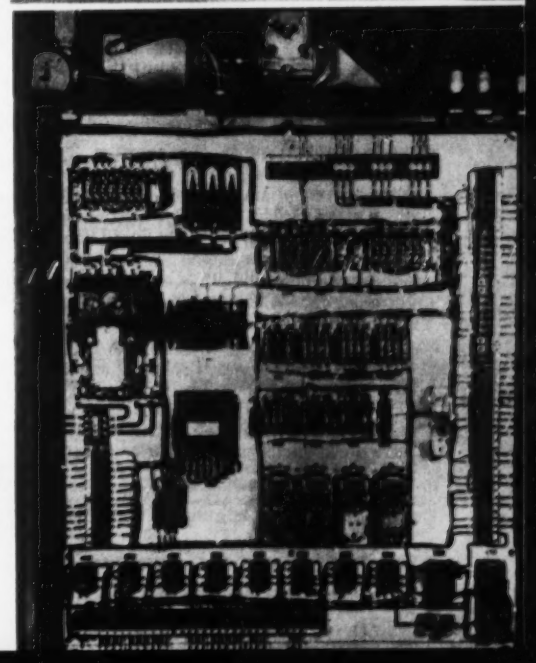

Fig. 8. Control panel for one lathe.

Water and Waste Treatment by

pH, ORP, and CONDUCTIVITY

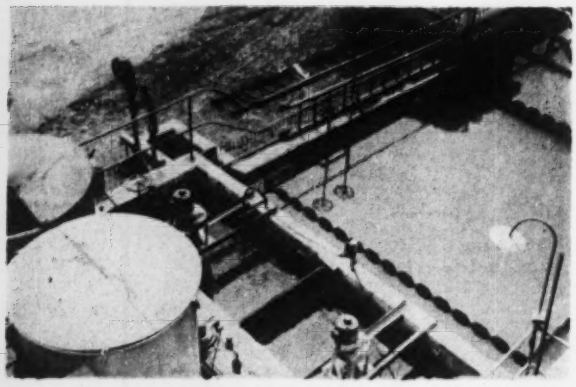

Fig. 1 Typical pH control application, showing chemical feed tanks and neutralization facilities.

by W. WESLEY ECKENFELDER, JR.
Manhattan College

Process characteristics now used in automatic control of water, sewage, and industrial wastes include pH, oxidation-reduction potential (ORP), and conductivity. Typical applications show where each finds use.

EFFICIENT OPERATION of water and waste treatment processes frequently requires a high degree of process control. Manual control of many process variables is difficult and frequently impossible. In order to maintain the necessary degree of control, a variable must be selected which is susceptible to accurate and continuous measurement and which quantitatively responds to changes in process characteristics—conductivity, ORP, and pH are frequently used.

pH

pH is a measure of the effective acidity or alkalinity of a solution. It is defined as the log of the reciprocal of the hydrogen-ion concentration. For example, a solution of pH 4.0 is 1,000 times as acid as a solution of pH 7.0.

The measuring system consists of a glass electrode and a calomel reference electrode. The glass electrode contains a solution of constant hydrogen-ion (pH) concentration which is separated from the unknown pH to be measured by a thin glass membrane. The pH differential generates a potential which varies with the hydrogen-ion concentration in the solution.

The calomel reference electrode contains mercury and mercurous chloride in contact with saturated potassium chloride, which serves as a liquid junction between the calomel and the solution to be measured. This electrode produces a constant potential regardless of composition changes in the water.

Primary considerations in the design and operation of a pH control system have been developed by Greer[1, 2]. The pH controller may modulate the output rate of a chemical feeder directly. Variations in the rate of flow of water or waste and in the rate of change of pH must be considered in the selection and sizing of control valves and chemical feed equipment. These factors also determine the sizing of a mixing tank to provide adequate retention. Retention is required to equalize flow and pH variation in the waste and to provide sufficient time of reaction for added chemicals. Frost[3] has recommended that a retention of three to ten times the maximum rate of water or waste flow per minute be provided. Agitation and mixing equipment is desirable to reduce measurement lags and to insure a rapid contact of chemical feed and water or waste.

The range of pH desired in the treated effluent is a major factor in process controllability. Due to the logarithmic characteristic of pH, additions of acid or alkali near neutrality cause rapid change in pH, while large quantities of chemical are required to cause pH change in the acid or caustic ranges. The buffering characteristics of the water or waste to be treated and the desired control point must be carefully considered in the final design.

Lags should be minimized. The detection lag (time interval between change in chemical feed rate and measurement change) should be maintained between 0.5 and 1.0 minute[1]. The necessity for reducing lags caused by process changes to a minimum may dictate the use of a proportional controller with provision for wide proportional-band adjustment, automatic reset, and rate action. In waters or wastes where the pH characteristics may vary from highly basic to highly acidic, a dual control system employing two control valves must be used, as in Fig. 2.

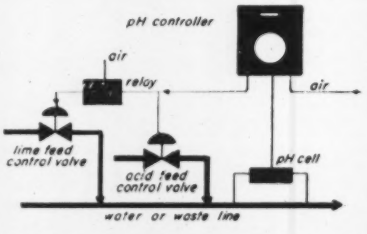

Fig. 2. pH control system using both caustic and acid control valves required because of wide variation of waste-line products from highly basic to highly acid.

Optimum flocculation processes are a function of pH. In order to attain maximum effluent clarity and minimum floc solubility, critical control of pH over narrow limits is necessary. For example, in chemical treatment of refinery waste waters, Austin[4] found that pH adjustment to 8.5 for alum flocculation, and adjustment to pH 9.0 when ferrous sulfate is used, produced best results. In acidic ranges no floc was formed; a non-settling floc was formed above the optimum range.

Hauck and Eger[5] report that pH control yields a 40-percent reduction in consumption of alum due to the elimination of overfeeds.

In order to insure maximum removal in the precipitation of the oxides of iron and manganese, the pH should be maintained in the high alkaline range.

In work done at Lowell, Mass. Babcock[6] found it necessary to maintain a pH of 8.5 to 9.1 in order to remove the iron and to reduce the manganese to a point where the remainder could be removed on sand filters.

Other water applications include the recarbonation of lime or lime soda-ash softened water; the rate of feed of carbon dioxide may be pH controlled through a control valve to minimize after-precipitation from alkaline water or corrosive action by acidic water.

Industrial wastes from metal-plating operations and chemical plants often

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have highly alkaline or acidic properties and must be neutralized prior to discharge into a sewer or stream.

A variable pH is characteristic of many organic industrial wastes. Fig. 3 shows the pH characteristics of a typical peach waste. Biological waste-treatment processes are not tolerant of rapid fluctuations in pH or of a sustained pH beyond the limits of bacterial activity. To illustrate this, a system treating food wastes was subjected to a pH change of 7.4 to 10.3, resulting in a decrease in the oxygen utilization rate from 44 to 12.4 ppm/hr. Recovery from these process upsets may require several hours.

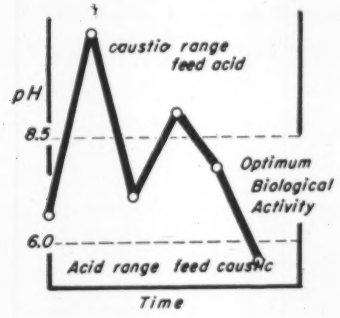

Fig. 3. Variation in pH of peach waste, showing wide variations.

Oxidation-reduction Potential

Virtually all biological processes and many chemical processes in waste treatment may be defined as oxidation-reduction reactions. Recent advances have made it possible to use the ORP characteristics of a system for control.

The measurement system is similar to that employed for pH, except that a platinum or gold electrode is substituted for the glass electrode. This is used with a calomel reference cell. The flow or bore-type electrode is preferred to minimize electrode fouling. The design and control considerations for ORP systems are similar to those for pH control except when decomposable biological substrates are involved. Equalizing or holding basins cannot be used because the oxidation-reduction characteristics of a biological mass change rapidly with time. Hence, it is essential that the primary device be placed as close to the biological system as possible, and lags between the active biological system and the measuring device be minimized.

The ORP is influenced by temperature and pH. Where these factors vary widely, they must be controlled or compensated for.

The ORP is a function of the ratio between the concentrations of oxidant and reductant:

$$E_h = C + K \log \frac{\text{(oxidized ion)}}{\text{(reduced ion)}}$$

in which E_h is oxidation-reduction potential, C is a constant characteristic of the particular reaction, and K is the equilibrium constant. In biological systems, oxidant is furnished in the form of oxygen or chlorine; reductant is supplied by organic matter activated by the enzyme systems of the biological mass. In a continuous biological system such as the activated-sludge process, an ORP-control system can be used to regulate the flow of oxidant (air) in response to load change (reductant)[6]. If there is no formation of intermediate products, the oxygen supplied to the system is the principal source of oxidant, and the organic loading or BOD removed is the principal source of reductant. A control valve may be employed to regulate the rate of air flow to the process to maintain the potential constant as the loading changes. Over a given time interval, under ORP control, variations in loading will be reflected by proportional variations in the rate of air flow. Fig. 4 shows the relative relationships of process variables at constant ORP.

Maximum power economy can be attained by employing controls to start up and shut down blowers in response to air demand rates. A uniform rate of output may be obtained by using a variable-speed blower in parallel with one or more constant-speed units.

The oxidation-reduction properties of a biological system also can be employed to adjust the rates of nutrient chemical addition. Since the rate of ammonia or phosphorus utilization is proportional to the rate of oxidation, a pneumatic control valve can regulate this chemical feed by ratio control from a controlled air flow rate. This function may be expressed:

$$\text{BOD (organic carbon)} + NH_3 + O_2 \longrightarrow \text{Sludge} + CO_2 + H_2O$$

In many chemical systems, the oxidation-reduction properties of the system can be used to provide economical and efficient treatment. For example, the reduction of hexavalent chromium to the trivalent state with ferrous sulfate, metabisulfite, or sulfur dioxide is an oxidation-reduction reaction occurring in the acidic pH range. The addition of chemical and acid may be regulated through a control system at the potential where the reduction is complete. Complete reduction of chromium occurs between 490 and 500 millivolts in an acid medium[5].

Conductivity

The ability of a system to conduct an electric current is known as its electrolytic, or solution, conductivity. This property is related to the concentration, composition, and the ionic state of the dissolved salts in the water or waste.

Conductivity is measured by use of an a-c Wheatstone bridge. Alternating current is used to avoid polarization of the electrodes.

The electrode system consists of two platinum electrodes in a chamber. A flow, or bore-type, electrode can be used.

Commercial conductivity cells are constructed of varying size and spacing. This permits a selection of a cell for specific applications to avoid the measurement of extremely high or extremely low resistances. The practical limits for resistance measurement are 50 and 100,000 ohms. A correction factor, termed the cell constant, relates the actual measured value to the standard value. As conductance varies with temperature, a temperature compensation element is usually added.

Functional control of many water and waste processes is based on controlling the concentration of dissolved solids in the process stream. Automatic regeneration of deionizing equipment may be obtained by monitoring effluent conductivities.

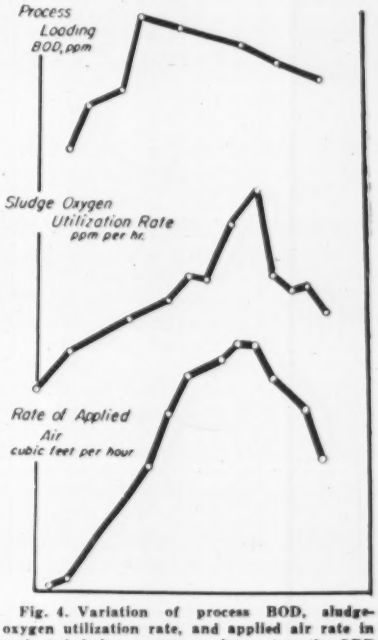

Fig. 4. Variation of process BOD, sludge-oxygen utilization rate, and applied air rate in activated-sludge process under automatic ORP control.

The discharge of many industrial wastes containing excessive concentrations of heavy metals or toxic compounds to industrial sewers or streams must be regulated to avoid deleterious effects on biological treatment processes or aquatic life. Conductivity control can be employed to close a waste discharge valve when waste concentrations exceed a desired value.

Conductivity is an excellent detector of leaks of acids or alkalis from closed systems.

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BOOSTER CONTROL

A pressure-booster control system for a coke-oven gas holder had to satisfy nine design criteria. The solutions are presented, with detailed discussion of the instrument air supply.

by FRANK REVELL
Koppers Company

COKE-OVEN GAS from the coke ovens is washed, cooled, and delivered to a gas holder. A booster on the holder exhaust raises the pressure of the gas from the holder to the pressure required for distribution purposes. The basic booster-control problem consists of changing the speed of the booster in accordance with the amount of surplus coke-oven gas available, as indicated by the height of the coke-oven-gas holder (Fig. 1).

Koppers Company's standard method of accomplishing this is to attach a pot containing kerosene to the bell of the holder, with sufficient flexible hose so that rise and fall of the bell imposes a hydraulic head on a pressure-measuring device which can be calibrated in feet of holder travel. On standard jobs a hydraulically operated control system changes the amount of steam to the turbine-driven booster, or changes the vanes on a power wheel for motor-driven boosters.

This method is wasteful because as the holder rises, the booster speed is increased, consuming more power to raise the pressure in the discharge line even though no increase in volume is called for. This is particularly true at periods of low usage, such as a week-end.

In order to save this power we add a discharge-pressure override to the controller. At times of low usage the pressure rises to a set point, then the pressure override takes over automatically and slows the booster. Generally this occurs at times when the holder is in its high position and gas is being bled to atmosphere.

Occasionally we run into a problem that is a little more complicated. One steel company wanted to use a motor-driven booster, but would not use a power wheel. In order to get variable volume we had to use a hydraulic coupling. The equipment (Fig. 1) consists of a 1750-hp. motor, a speed gear, an American Blower hydraulic coupling, and an Allis-Chalmers 5-stage centrifugal booster.

The motor is a 1750-hp., 900-rpm., 2300-volt, 3-phase, 60-cycle synchronous motor. The speed gear is a Falk Corp. speed increaser from 900 to 4000, the hydraulic coupling is an American Blower "Type VS-6 Gyrol." The driven end of this coupling rotates at a constant speed of 4000 rpm. The variation in speed for driving the booster is accomplished by use of a dip tube, which fixes the amount of oil in the coupling section. The more oil, the more power transmitted, and vice versa. Control is obtained by positioning this dip tube.

Design Criteria

Nine design stipulations were developed through discussions with the motor, coupling, and booster vendors, the steel company's operating and engineering departments, and all departments of Koppers Engineering & Construction Division. These were as follows:

1. Control must not shut booster down. The privilege of taking the booster out of service is to be reserved for the overload controls in the electric circuit, or for the operator.
2. Speed of booster is to be controlled, primarily, from holder height.
3. Control must have discharge pressure override so that high discharge-pressure slows booster down.
4. Motor must be started under "no load" conditions.
5. Motor once in operation must not exceed an overload current of 15 percent above normal.
6. Booster must not become unstable when the throughput becomes less than 12,000 cfm.
7. All control functions must be operable from a panel board.
8. All valves must be hand operable.
9. Control must also operate a standby steam-driven booster.

Instrument Air System

After we started the job we decided to go to air-operated controllers. To insure a dependable source of instrument air we use two compressors, one electric-motor-driven and one steam-turbine driven. The motor-driven compressor is the primary source, but enough steam is bled into the steam turbine to keep it warm, and an automatic cut-in starts the steam compressor if air pressure drops to a set point. This assures us a supply of instrument air in event of either power or steam failure. After the compressors the air passes through a J. S. Murphy aftercooler and separator, thence out of the building to an air receiver. From the receiver, air re-enters the building and goes through an oil-vapor absorber. From the absorbers the air enters a Kemp dual-tower dessicant-type air dryer with automatic reactivation. This system assures us of dry, clean instrument air with a dew point of minus 10 deg. F. at 100 psig. A word of warning: Do not buy anyone's air-operated equipment and expect it to work on wet, dirty air.

Booster Control System

At the top of Fig. 1 is shown "LRC-PRC-209"—a level-recording-controller and pressure-recording-controller. Note that there are two control functions, but only one air output line to the control valve.

One impulse line into this instrument measures the height of the holder by the changing position of our kerosene pot as it rides up and down on the bell of the holder. The other impulse is taken from the discharge line of the compressors. Each of these measuring elements operates its own control components—that is, it has its own throttling bellows, reset bellows, 2nd-derivative bellows, and flapper-and-nozzle assembly with control-setting knob and control index. There is, however, only one air relay in the system. The nozzle assemblies are piped together and a line from this common pipe goes to the diaphragm which operates the relay.

Let us assume that we want the level to do the controlling. By setting the *pressure control* at the top of the chart we cause the pressure flapper to go to one extreme, putting full air output from the relay. However, as the flapper on

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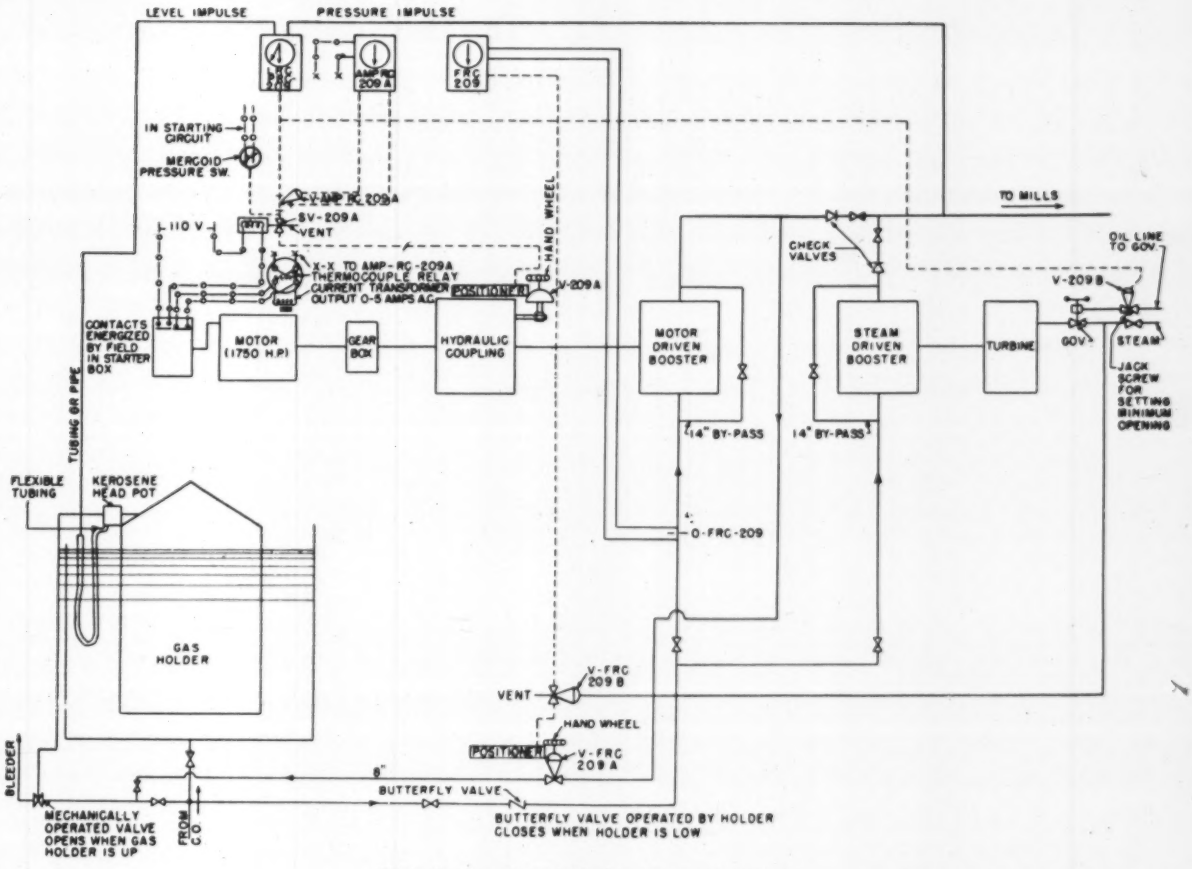


Block diagram of gas-holder-booster control system.

the level control is open to hold at control, it determines the pressure of the relay diaphragm. By setting the level at ¾ position (normal operating range) and by setting the pressure at 7 psi. (one pound above normal), we have met two of our primary conditions—(2) booster to be controlled by holder height and (3) control to have pressure override.

Note that we have passed over the first condition—that the controllers must not shut the booster down. None of our controllers will stop the booster, but we have several safety devices whose functions must be satisfied before the motor can be started:

(a) Auxiliary oil pump must be operating. There is a Mercoid pressure switch in the starting circuit to the big motor.

(b) No air output from control instruments. The Mercoid pressure switch shown between the instruments and the three-way solenoid ties into the starting circuit.

The *motor-control circuit* has an over-amperage relay, a phase relay, a time-delay synchronous relay, etc. The starting circuit is 2300 volts through a 60-percent reactor. Starting voltage is about 1400 volts. If all conditions are satisfied the motor is up to synchronous speed (900 rpm.) in 15 seconds; within 20 seconds thereafter full voltage is applied and the d-c. field is applied.

In order to start the motor under no-load conditions the solenoid valve SV-209A was placed in the air line from the instruments to the dip tube on the fluid drive. This three-way valve does not become energized until the motor is up to running speed, as shown by the contactor in the starter box in Fig. 1. With no air on the diaphragm of V-209A the dip-tube operator is at its zero position and the motor, Falk gear, and one half of the fluid drive will operate at 4000 rpm. without turning the booster over.

The fifth condition (motor overload) was met by using the second instrument at the top of Fig. 1—"Amp RC-209A." This is a temperature instrument that operates from a Weston thermal element. The 600-ampere to 5-ampere current transformer shown is wired to a thermal element. This is a high-ohmage resistor with a thermocouple above the resistor. The instrument is calibrated in amperes, but reads temperature changes as indicated by the thermocouple.

The normal operating range of the motor is 435 amps. The control instrument is set at 455 to 460. If the load reaches the set point, the amperage controller throws the air-operated valve ahead of the three-way solenoid, shutting off air from the level-pressure controller and sending its own control air to the dip-tube operator, slowing the booster. The air relay to the three-way valve "V-Amp RC-209A" is a lock-up relay so that the amperage must drop back to say 438 amperes before the instrument returns control to the primary controller. The lock-up relay merely keeps the control from fluttering back and forth.

In order to stabilize the booster at low flow (condition 6) it was necessary to add a separate control system. "FRC-209" measures the flow to the motor-driven booster and opens a by-pass at low flow to maintain the necessary 12,000 cfm. through the booster.

The seventh condition is met by switching any instrument on the board to manual, and adjusting air output to the control valves.

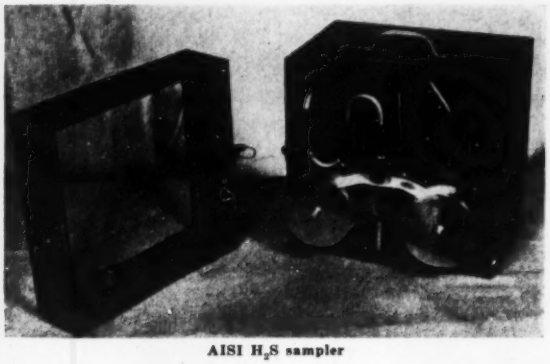
The eighth condition is met by having hand-wheel extensions on all control valves.

The air output from "LRC-PRC-209" goes directly to the steam-driven compressor, and operates a valve in the oil line to the control governor, thus meeting the ninth condition.

Methods and Instrumentation for

AIR SAMPLING

by LAWRENCE F. DIERINGER* and W. T. INGRAM**



AISI H_2S sampler

Primary problem in air-pollution analysis is sampling. Sampling techniques for particulate matter include sedimentation, filtration, impingement, electrostatic precipitation, and thermal precipitation. For gases, techniques used are absorption, combustion, adsorption, and freezing, combined with titration, colorimetric, and conductivity measurements.

AIR-POLLUTION conditions have existed for centuries. However, it was not until the turn of the twentieth century that public clamor necessitated action towards reduction of air pollutants.

A vital step in evaluating any air-pollution problem is the establishment of a sampling program to determine significant points of discharge of the contaminants and to determine the extent of atmospheric dispersal. This article discusses instrumentation and sampling methodology presently employed in air-pollution studies.

Sampling techniques of industrial hygiene differ from those of atmospheric pollution; the differences are largely a matter of concentration. Atmospheric-pollution study may require sampling of both heavily polluted air, such as stack sampling, and air containing extremely minute quantities of pollutants, as in ordinary urban atmospheres.

Atmospheric pollutants are of two types—particulate and gaseous. Some pollutants exist in both forms, for example, fluoride gas and fluoride salts. In such event the state must be known in order to determine the sampling device to employ.

Particulate Matter

In collecting particulate matter, the basic problems are efficient separation and accurate measurement of the volume of air sampled. The sampling method should collect a sufficient quantity of material, and should not change the property to be studied. Thus, if particle size is important, the sampling device should not alter the particles during collection.

There are five basic methods of collecting samples of particulate matter—sedimentation, filtration, impingement, electrostatic precipitation, and thermal precipitation.

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Sedimentation

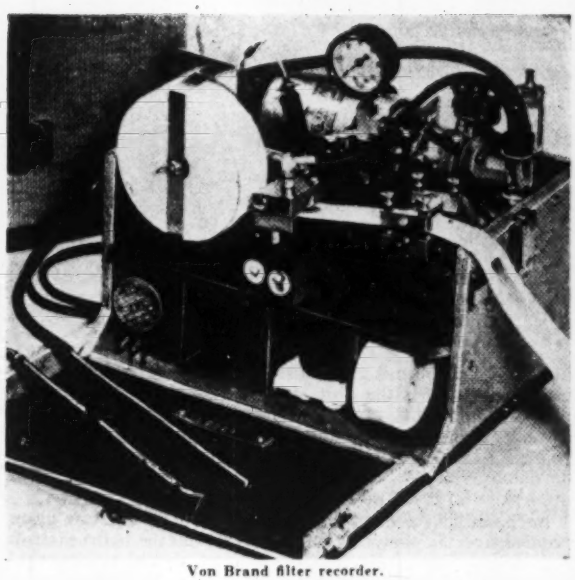
Sedimentation methods consist mainly of allowing the particulate matter in the atmosphere to settle out under gravity into containers or onto specially coated plates. The technique has short-comings, but is used and gives valuable information.

For forty years the deposit soot gage has been used extensively in England.[1] The gage consists of a large enamel funnel leading through a tube to a glass collecting bottle. Material settling in the funnel is washed by rain into the collecting bottle, collected monthly, and analyzed chemically. Many similar devices are used in this country.

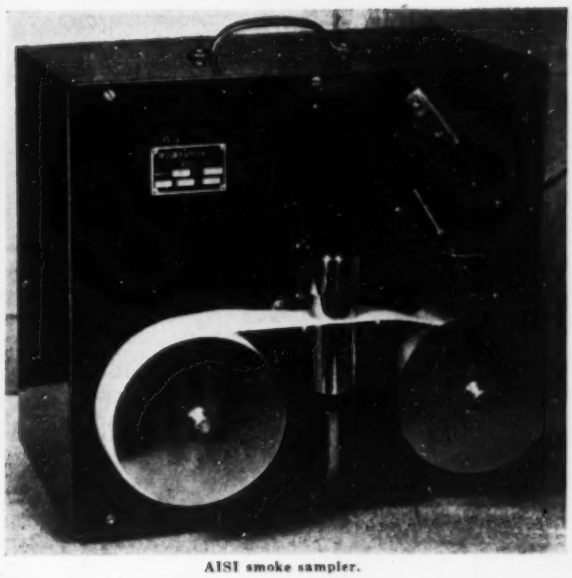
The most important short-coming in the use of sedimentary collection methods is the effect of weather, and wind in particular. Only the heavier particles settle out because prevailing winds prevent lighter suspended particles from settling. Munger[2], in attempts to reduce meteorological effects, has developed a directional dust-fall collection unit consisting of eight jars arranged in a circle, with a ninth jar in the center. Above the jars is a cover with a hole in the center and a hole in the periphery. The cover is rotated by a wind vane in such a way that a jar corresponding to the wind direction is uncovered. Another vertical wind-sensitive vane operates the closure so that either the center hole or outer hole is always uncovered. The shift is made either way as the wind velocity fluctuates over or under three miles per hour. The dust collected in each jar is weighed and, from information on wind direction, calculated to amount of dust per hour for a given wind direction.

Filtration

Filtration methods have developed along two lines. Owens[3] developed an automatic filter recorder for measuring pollution of city air. Two liters of air were aspirated through filter paper disks placed on the periphery of a revolving disk. By means of a clock mechanism, new filter paper was positioned over the aspirator device at intervals over a 24-hour sampling schedule; the color developed



Von Brand filter recorder.



AISI smoke sampler.

was compared to shade standards. The limitation on this method was the color of the filter-collected matter; unless the color was black, the shade-comparator relationship did not hold.

Davidson and Masters modified this automatic filter[4]. They replaced the water aspirator with a motor-driven pump and diaphragm gas meter, used a stripchart activated by a small synchronous motor to provide a record of atmospheric dust at selected time intervals, and compared the shade densities by a photoelectric scanning device.

Hemeon[5] has developed a simplified version of the automatic filter in which a diaphragm pump pulls 1/6 cfm. through a one-inch-diameter circle on a filter-paper tape. The tape, electrically controlled, shifts to the next position four times a day and hence provides for a long time exposure of the filter paper. Density of the filter spot can be obtained by density scale comparison, by optical evaluation or relative light transmission methods. Research is now in progress for use of this device with chemically impregnated filter-tapes for specific chemical contaminants.

Filtration sampling by passing air through high-purity analytical filter paper followed by direct weighing and/or treatment for chemical analysis is being used more and more. High efficiencies and high rates of sampling are possible. Silverman[6] has shown efficiencies ranging from 95-99 percent for cadmium and iron-oxide fumes. High-rate samplers use either fluted fiber filters or large filter sheets exposing a large filter area to permit the collection of particulate matter in minute quantity in the atmosphere for analysis. Whatman No. 41 filter paper is efficient for collection of small concentrations of sulfuric-acid mist from air samples of 50-60 cfm. for a one-hour period[7]. Eisenbud and co-workers[8] used Whatman No. 41 filter paper for collecting atmospheric samples in the vicinity of a plant producing beryllium compounds; the samples are analyzed for beryllium spectrographically.

The Stanford Research Institute[9] recently has reported developmental work on a sensitive method using impregnated filter paper for determination of gaseous fluorides. The filter paper is dipped into a chloroform solution of a fluorescent metal salt of 8 hydroxyquinoline and the solvent evaporated. The presence of gaseous fluorides in the atmosphere diminishes the fluorescence of the impregnated filter paper. Sensitivity is reported to be in the range of parts per billion. The work is being directed towards the development of a field instrument for determination of time of occurrences and variations in fluorescence due to fluorides.

A recent and promising development in aerosol analysis is the application of the molecular filter for sampling for particulate matter in the submicron range[27]. Preliminary tests over two years indicate high collecting efficiencies are obtainable, especially for submicroscopic particles. The filter consists of a dry gel of micellic structure whose elements, of molecular order of magnitude, are held permanently together by intermolecular forces. Its adaptability for aerosol analysis is due to a combination of properties which cause a unique retention mechanism for particulate matter within the molecular filter surface, almost independent of particle size.

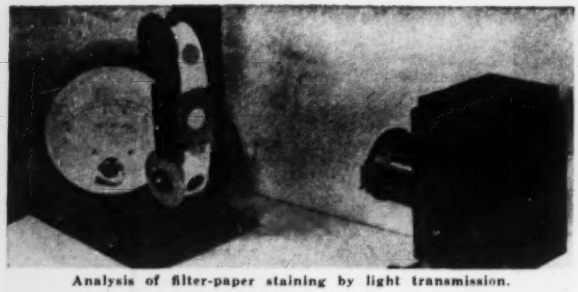
Impingement

Impingement sampling had its inception in the early twenties with the development of the Owens jet dust-counter in England[3], and with the Greenberg-Smith impinger developed a few years later in this country[10].

Jet dust-counter sampling involves drawing the air through a jet at high velocity and impinging the particulate against a glass slide; the adherence of the dust to the slide is aided by condensation of atmospheric moisture due to pressure reduction. In the Greenberg-Smith impinger the sampled air is passed through a small orifice to impinge at high velocity against a submerged plate, the sample then bubbles through the liquid. Two sizes of impingers are available—(1) the standard, which samples at a rate of one cubic foot per minute and (2) the midget, which samples at a rate of one-tenth cubic foot per minute. The Greenberg-Smith impinger requires a large pump and source of power; the midget impinger uses a small hand-operated pump. Impinger sampling has limitations; it is selective in particle size and collects only particles larger than one micron. The actual size collected depends to some extent on the wettability of the particles.

The cascade impactor described in England by Mays[11], and modified by Sonkin[12], is a specialized adaptation of the impingement principle whose potential use has not been developed fully. The impactor consists of multiple jets of decreasing orifice size arranged in series so that the air velocity increases at each succeeding orifice. As a result of this action a particle size distribution is obtained over the various stages, thus more accurate particle size information can be obtained. The instrument has been reported efficient as a sampler for determination of aerosols of mass median diameter of 0.25 micron. In connection with Los Angeles smog studies[13], however, it is reported to be highly efficient only for collecting particles above one micron in size.

Although not strictly an impingement-type sampling instrument, the *modified Venturi scrubber* has been found



Analysis of filter-paper staining by light transmission.

Arrangement for aspirating stack gases through filter paper.

useful for collecting sulfuric-acid droplets, particulate metal oxides, etc., in connection with the Los Angeles smog studies[14]. The instrument scrubs a large volume of air in a relatively short time with a small volume of water; the water is analyzed for particle size and chemical content.

Electrostatic Precipitation

Electrostatic precipitation at present probably offers the most satisfactory method for collecting particulate matter, fumes, and some mists. High collecting efficiency can be combined with high rate of sampling. In operation, an electrical charge is imparted to the particles in the air being drawn through the instrument. Forces of repulsion cause the particles to be caught in a collecting tube, from which they can be removed for weight determination and chemical analysis. Particle count and size measurements may be subject to error because of agglomeration of small particles owing to the electric charge involved.

A household-type Westinghouse "Precipitron" has been used successfully to obtain large quantities of particulate matter for chemical analysis in connection with the Los Angeles smog studies[14]. Also in connection with the smog studies, a wet-type precipitor has been developed for collecting sulfuric-acid mists[14]. The collecting electrode consists of a rotating stainless-steel plate partially immersed in a liquid bath. The mist collected on the rotating plate is washed off during rotation in a bath of either water or dilute sulfuric-acid. The conductivity of this washing solution then is measured continuously in a conductivity cell.

Thermal Precipitation

The *thermal precipitator* is seldom used in atmospheric pollution studies because of its low sampling-rate. The principle of operation, as pointed out by John Aitken about 1870[15], is based on the fact that a hot surface repulses particles, setting up a particle-free atmosphere around the hot surface. Thus, by passing air between a hot wire and adjacent glass plate it is possible to collect on the plate the particulate repelled from the wire. The thermal precipitator has the highest collecting efficiency of any sampling device yet developed, particularly for collection of particles It is particularly well adapted for collection on coated screens for subsequent examination by electron microscope. less than one micron in size. The instrument also has the advantage of collecting the sample in an unaltered state.

Gaseous Matter

The American Public Health Association Sub-Committee on Chemical Methods in Air Analysis in 1938-1939[16] classified gas-sampling devices into two groups—(1) those indicating the presence of the contaminant and (2) those absorbing devices which collect the sample so that a measurement may be made later. The well-known techniques for sampling high concentrations of gases are completely unsuitable for trace analysis work in air pollution.

In general, most gas-sampling methods rely on *absorption of the gas* in a collecting medium which will dissolve the gas or chemically combine with it.

The absorber should remove the gas efficiently. The efficiency should be tested against air containing known concentrations of gas, or by comparison with another method. The most satisfactory absorber would disperse the sampled air finely and permit great distance of travel in the absorbing chemical. Fritted sintered glass bubblers provide the greatest dispersion of any of the absorbers, whereas spiral or helical absorbers provide the maximum length of travel. Impingers have been used successfully for many gases, but do not provide for dispersion that may be required for the absorption of some of the less soluble gases.

Such methods are not universally applicable; certain gases require special sampling methods. Aromatic hydrocarbons (such as benzene, toluene, and xylene) should be absorbed in nitrating acid in a fritted-glass Petri dish or in a glass-beaded column at low flow rates.

Combustion techniques have been applied to the collection and determination of halogenated hydrocarbons in the atmosphere. The air is drawn through a heated tube where the halogen is liberated by destruction of the hydrocarbon, and the halogen absorbed in a suitable material for chemical analysis.

Adsorption on solid material also has been employed, the most common adsorbents being activated charcoal and silica gel. Although highly efficient, they do not have universal application.

Attempts to determine the constituents of the famous Los Angeles smog have taxed the ingenuity of research staffs. The effort has been noteworthy in the application of modifications of known methods and development of new sampling techniques for the collection and analysis of organic compounds in the atmosphere. The procedures for determining the more complex aldehydes, oxidants, petroleum vapors, and hydrocarbons, of necessity, are more specialized and demanding than those for inorganic gases.

Organic Compounds

A method has been developed whereby organic compounds are collected by freezing them out of the atmosphere with liquid nitrogen. In a freeze-out train the air is formed successfully through three traps, the first and second kept at –80 deg. C. by dry ice, and the third kept at –195 deg. C. by liquid nitrogen[14]. The gaseous organic impurities are condensed on the walls of the traps, and their concentration determined by evaporating an ether extract. Infrared spectrophotometer analysis of oxygenation hydrocarbons collected in freeze-out trains has been made possible by use of a large gas cell with rock-salt windows.

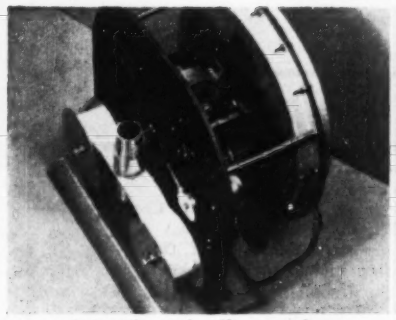
Hydrocarbons

McCabe[19] has described an activated-carbon collecting unit for sampling for petroleum and hydrocarbon vapor, odors, and aromatics. The unit consists of dual perforated activated-carbon counters containing a uniformly dense 0.7-inch layer of 6-14 mesh granular activated-carbon, through which 40 cfm. of air at a rate of 25 feet per minute is passed.

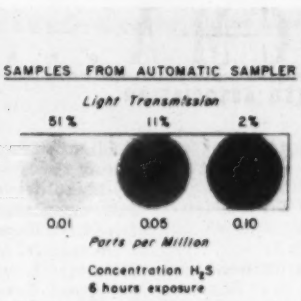
Sulfur Dioxide

No discussion of sampling methods and techniques would be complete without devoting time to *sulfur dioxide*, one of the most common air contaminants. Sulfur dioxide can be found where coal is burned, where smeltering occurs, or where sulfur is given off at a manufacturing operation.

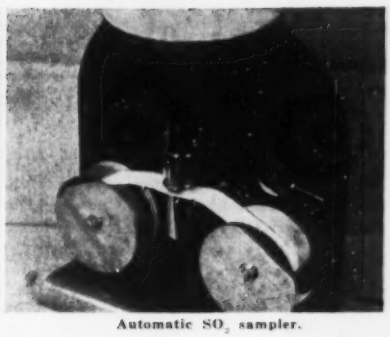
The Wells-Marston method developed in 1915 in connection with the famous Selby Smelter Cases[20], or its later modifi-



Automatic smoke filter sampler.



Samples from automatic sampler.



Automatic SO_2 sampler.

cations still finds considerable use[21]. In actual sampling, requiring less than 15 seconds, an evacuated aspirator bottle was exposed to the atmosphere under question, and collected samples washed with starch solution colored by iodine. Simultaneously, a blank sample was run. The two samples were then titrated with iodine and a color comparison made between the colors of the samples and the blank solution.

Thomas, in the last 25 years, has developed the now-famous Thomas "Autometer" for automatic determination of sulfur dioxide. The first adaptation[22] used two absorbers for titration, one being charged automatically with fresh starch-iodide solution, while a sample was being aspirated through the other. Thomas[23], in collaboration with Abersold, modified this apparatus to make it fully automatic by changing the absorbent to slightly acidulated distilled-water containing hydrogen peroxide, enabling the use of conductimetric measurements. In 1946 further modifications enabled a continuous sample of air to be pumped counter-current to the flow of hydrogen-peroxide and sulfuric-acid solution in an absorbing column. The resulting change in electrolytic conductivity of the solution is determined by a conductivity cell and recorded on a sheet recorder[24]. Efficiencies of from 95 to 98 percent for concentration ranging from 2 to 24 ppm. sulfur dioxide are obtainable. Other gases, such as hydrochloric acid and oxides of nitrogen, which impart conductive properties to the absorbing solutions, will affect the readings.

Another recent instrument available for automatic sulfur-dioxide measurements is the "Titrilog"[25]. It consists essentially of a chemical cell in which titration takes place between potassium-bromide electrolyte and the air sample. Bromine produced is proportional to the output current of a d-c. amplifier, and the concentration of bromine produces a voltage on the electrode connected to the d-c. amplifier input. The presence of sulfur dioxide reduces the bromine concentration temporarily. The record of current output with constant flow of sample will show sulfur-dioxide concentration in relation to time. Other gases such as hydrogen sulfide, sulfides, and mercaptans influence the results.

Since 1931, the volumetric method of measuring atmospheric concentrations of sulfur dioxide has been employed in England[1]; 50 cubic feet of air per day are drawn through a bubbler containing 40 ml. of dilute hydrogen peroxide. The resulting sulfuric acid is titrated with sodium hydroxide to a pH of 4.5. The method has been adapted also for use with the Owens automatic smoke filter described earlier, particulate matter first being removed by the filter paper and the gas through the sulfur-dioxide bubbles.

Conclusion

Investigative efforts of today still are being directed towards improvement of instrumentation to obtain higher collection efficiencies. Large analytical strides have been made possible by photoelectric devices and application of chemical instrumentation to collected samples.

Little is known about the extent of error introduced by such meteorological factors as air turbulence, wind, temperature inversion, and weather.

There is need for further development of continuous automatic recording instruments that are specific with respect to what they measure and respond quickly to concentration changes. More efficient equipment for collecting and concentrating gaseous impurities are needed to assist in their identification by infrared and ultraviolet spectrography. Existing analytical methods for determination of gaseous impurities lack sensitivity and are tedious. These are only a few of the general types of unsolved problems.

Brown and Schrenk[26] have set forth an excellent group of requirements for methods of atmospheric sampling and analyses. Few, if any, of today's methods meet all the desired requirements for accuracy, dependability, and ease of use.

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Journal of the S C M A . . .

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VALVE POSITIONERS

Important valve-positioner factors include principles, components, types, application, and maintenance.

by MAYNARD STRADER
Union Oil Co. of Calif.

MOST COMMON USE of a valve positioner is to insure that the control-valve stem position is proportional to the instrument output pressure in the presence of stuffing-box friction or off-balance forces on the valve plug. Stuffing-box friction is often found in: (1) high-temperature service (over 500 deg. F.), (2) high-pressure service (over 500 psi.), (3) difficult packing conditions for butane, propane, superheated steam, and other materials which tend to dry out packing, (4) coking service, and (5) corrosive service.

Valve positioners will increase the stability where large pressure-drops are encountered and where single-seated valves are used. In addition, valve positioners have other applications, such as use with wide proportional bands (found in averaging-type level controllers and temperature control where slow temperature changes are encountered). The positioner increases the sensitivity of the valve to small changes of instrument output pressure.

A popular application for a valve positioner is to "split the range" of two or three standard-range valves. Any desired portion of the controller output pressure (say 7 to 13 psi.) may cause the valve positioner to move the valve through its entire stroke.

Another application of a positioner is to give a desired valve characteristic (valve plug position vs. controller output pressure) other than proportional.

August Meeting: Thursday, the 19th, Rio Hondo Country Club, Downey, Calif.

Feature: Mr. H. C. Earle, Jr., Annin Company, will present a talk on "Single Seated Control Valves—Their Design and Application.

Principle of Operation

When a positioner is installed on a valve, the valve is no longer operated directly by the instrument output pressure. The positioner receives the instrument output pressure and controls an independent pressure supply to furnish whatever diaphragm pressure is required to force the valve stem to the correct position. Thus the positioner is a relay capable of applying maximum force to correctly position the valve stem. A "take-off" linkage provides the "follow-up," which is part of the positioner mechanism.

There are now two basic types of valve positioners—the deflection type and the force-balance type.

The *deflection type* (Fig. 1) is actuated by both (1) the deflection, or motion, of the bellows receiving instrument air output pressure and (2) the motion of the valve stem. Both of these motions operate the pilot to maintain proportionality between the bellows deflection and the valve-stem position. If the instrument air pressure increases, the pilot will open to increase the air pressure to the valve; if the valve does not move, the pressure to the diaphragm continues to increase. When the valve plug does move, the pilot will close and the valve will be balanced in a new position.

A common type of pilot is the 3-way valve (as shown in Fig. 1), which requires a very small motion to operate. Some positioners use a flapper-and-nozzle arrangement; others use a pilot relay plus flapper and nozzle.

The *force-balance* type of positioner (Fig. 2) is actuated by both (1) the force created by the bellows receiving instrument air output pressure and (2) the force caused by a spring connected to the valve stem. The instrument output pressure in the positioner bellows is utilized only as a proportional force. The valve stem position is converted to a proportional force by means of a

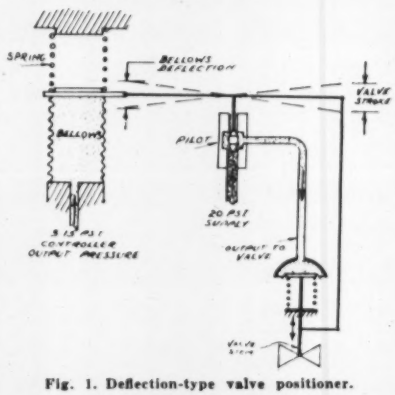

Fig. 1. Deflection-type valve positioner.

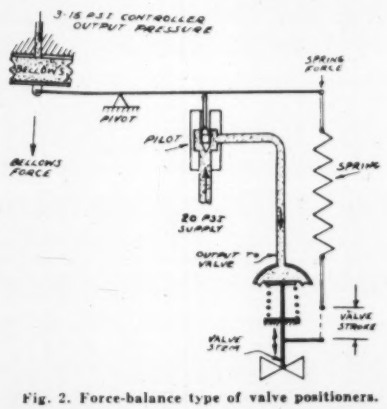

Fig. 2. Force-balance type of valve positioners.

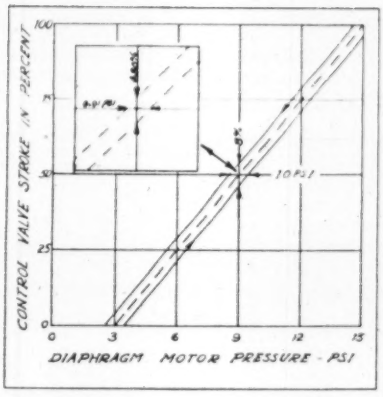

Fig. 3. Effect of valve positioner on control-valve action. Solid line shows valve action without positioner; dotted line shows valve action with positioner.

spring; the two forces are compared on a "beam-balance" lever, which also actuates the pilot to maintain the two forces proportional.

Although the two types do the same job, there are the following differences: (1) In the deflection type a substantial deflection must be taken by the bellows. Negligible force is applied by the mechanism to the valve stem. (2) In the force-balance type negligible deflection of the bellow is required. The mechanism does apply a force to the valve stem.

The bellows deflection in the force-balance type is so small that the deflection characteristic of the bellows is eliminated and the bellows length (also the number of convolutions) can be small, which saves space. The force applied to the valve stem does not affect the accuracy of the positioning because the pilot automatically applies the correct pressure to the valve diaphragm to overcome this force as well as others in the valve. This force, if not excessive, is desirable since some additional spring force would otherwise be necessary to remove lost motion in the linkage between valve positioner and valve stem.

Included in the mechanism is a linkage necessary to permit adjustment of the positioner to various valve-stroke requirements. Most positioners use the familiar parallel lever linkage to permit adjustment to a wide range of valve strokes. In the force-balance-type positioner the use of this linkage causes the force exerted on the valve to vary inversely with the stroke setting.

Pilot Valves

The valve positioner varies an independent source of constant-pressure air to supply whatever pressure is required to the diaphragm of the control valve to satisfy the relationship that the valve stem position be directly proportional to the instrument output pressure. The air usually is controlled by a pilot valve.

The general requirements of the pilot are: (1) operation on small motion, (2) adequate capacity to actuate the valve rapidly, (3) low air consumption, and (4) simplicity. Some positioners utilize a second relay, or booster pilot, but many positioners of recent design use a single directly-operated pilot.

The three-way pilot valve satisfies these requirements. In this type of pilot a double-seated plug controls the flow of air from the supply port to the output port, and from the output port to the exhaust port. The position of the plug determines the output pressure. As both the inlet and exhaust ports are operated simultaneously, a pilot with high sensitivity plus ample air capacity can be obtained. Only 30 percent of the total stroke of the pilot is required to change the output pressure from 3 to 15 psi. If reverse action of the control valve is desired, a 3-way pilot valve with reversed seating can be used.

Positioner Action on Valve

To describe the action of a valve positioner, consider a valve having a very tight stuffing box. Without a positioner (Fig. 3) a "flat-spot" or "dead-zone" is caused by the stuffing-box friction. A considerable change in diaphragm pressure is required to reverse the valve stem movement. If this pressure were, for example, 1 psi., it would represent approximately 8 percent of the 12 psi. (3-to-15 psi.) required to stroke the valve. This 8-percent flat spot in the valve stroke would result in severe cycling in many applications.

With the installation of a positioner on this valve, the flat spot is reduced. If, for example, only an 0.08-percent change in instrument air pressure to the positioner is required to change the positioner output 1 psi., the instrument pressure would change only 0.01 psi. to reverse the valve. This is 0.08 percent of the 12-psi. instrument air span. The "flat-spot" is now only 1/100 of what it was without the positioner.

The accuracy of a positioner may be expressed as the percentage of total instrument output pressure range required to change the positioner output a given amount.

Special Applications

In addition to a direct and proportional action, other valve characteristics can be obtained by using a positioner having a specialized characteristic (Fig. 4). One type can be used to match the characteristics of the control valve with control demand or with parallel devices. This type of positioner has a cam of a shape which causes the characteristics of the control demand vs. the rate of flow through the valve to match similar characteristics of other power devices operating in parallel with the control valve.

Some positioners have a speed adjustment. When the control system involves only a single valve, a high valve-positioning speed is usually an advantage. However, in a complex control system it is generally desirable to operate all power devices at the same speed in order to avoid either interaction between units or other undesirable process conditions during load changes. To reduce the speed of the positioner action, an orifice is inserted in the line from pilot valve to diaphragm motor.

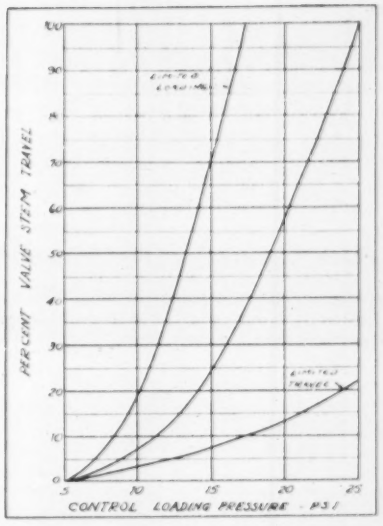

Fig. 4. Square-root-type positioner characteristics.

Volume Booster

A recent valve-positioning device is the volume booster, or booster relay. Where speed of valve action is the only problem, a volume booster answers the requirement. It is simply a relay receiving instrument air output to control supply air (up to 100 psi.) to the diaphragm in large quantities. Its output pressure may be equal to the instrument air or one-half, one-third, two times, three times, or so on.

One interesting use of a volume booster is on large single-seated gas valves where unbalanced forces on the plug are present. A standard air-to-close valve is piped so that the flow enters under the plug. In order to close the valve a pressure equal to the sum of the 15-psi. spring plus the off-balance pressure under the plug is required. Calculations indicate that almost twice the 15-psi. instrument air output is required. One solution is to use a volume booster.

Maintenance

A valve positioner usually is serviced at the same time that its control valve is lubricated or repaired. If it is necessary to remove the control valve to repair it in the shop, some companies prefer to have the positioner taken off the valve first so that there will be less chance of damaging it. When the control valve is serviced in place, often the positioner and valve are checked.

When a positioner is removed from the valve it may be cleaned and checked for defective parts. After reinstallation its operation should be checked. This can be done readily by use of a valve-positioner tester, which consists of an air regulator to simulate instrument output pressure, the necessary gages, air hoses, and fittings. If the positioner includes self-contained gages, they may be used; however, the tester gages for instrument air and diaphragm air may be preferred because of their accuracy.

Briefs . . .

Instruments and AUTOMATION

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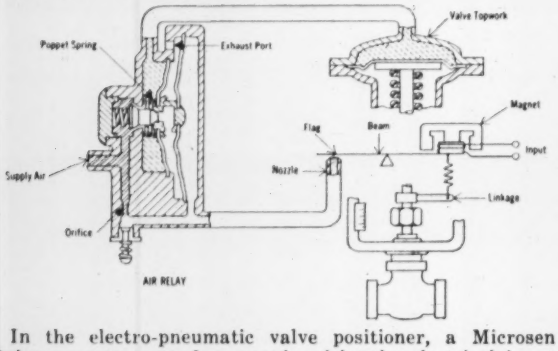


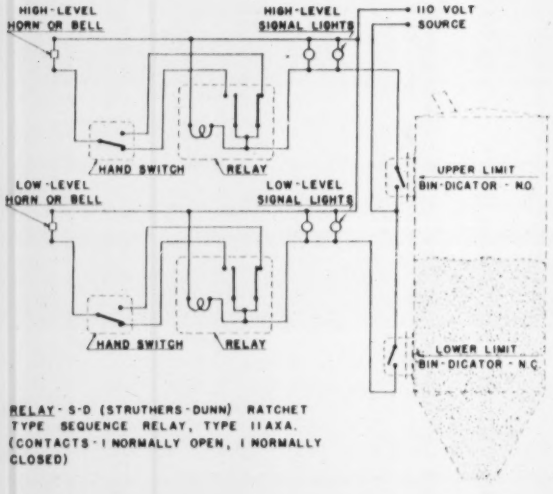
In the electro-pneumatic valve positioner, a Microsen Balance compares a force produced by the electrical input against one produced by a calibrated spring which measures the valve stem position. (*From new* 30*-page Catalog* 164, *"American Electronic Process Control," Manning, Maxwell & Moore, Inc., Stratford, Conn.*)

For this literature circle **401** on inquiry card.

Bin Control

The Bin-Dicator is essentially a diaphragm-operated switch designed for operation on all bulk materials that will flow through a bin. A flexible diaphragm is exposed to the material in the bin; as the material builds up to the Bin-Dicator, pressure of the material forces the diaphragm against the counterweighted lever mechanism. As the lever mechanism is tipped in response to this pressure the switch located in the Bin-Dicator housing is actuated, and automatically controls signal lights, horns, bells, conveyors or feeding machinery. (*From new* 20*-page Form BD-5A, Bin-Dicator Co., Detroit* 15, *Mich.*)

For this literature circle **402** on inquiry card.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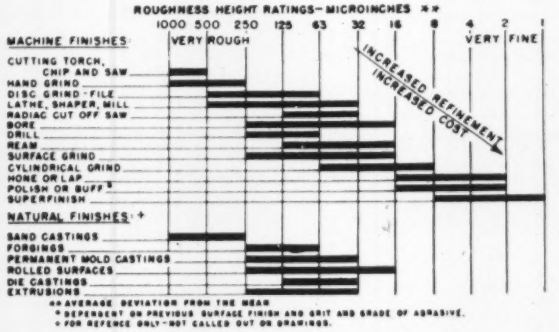

(*From* 4*-page brochure, Surface Checking Gage Co., Hollywood* 28, *Calif.*)

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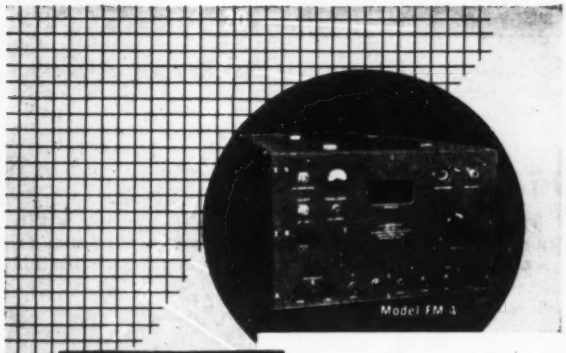

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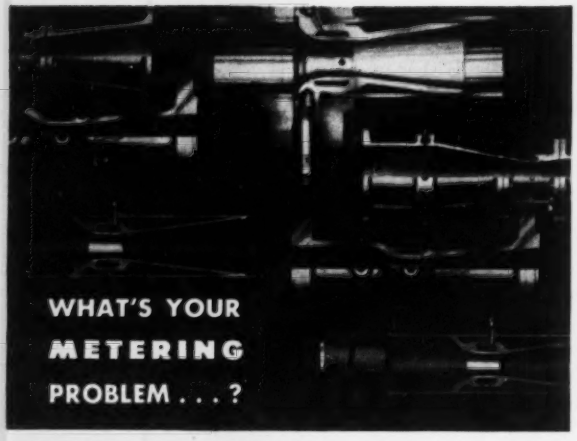

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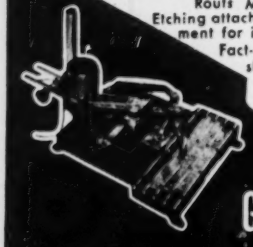

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the hydrogen concentration in the original sample. (*From new 4-page Bulletin* 301, *Taller & Cooper*, 75 *Front St., Brooklyn, N. Y.*)

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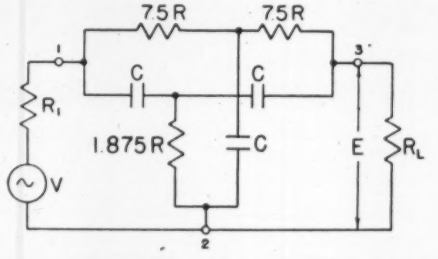
Filter Networks

The twin-T (or parallel-T) resistance-capacitance filter transmits signals of any frequency except a particular frequency at its null point . . . used as frequency-determining



elements and response-modifying circuits at low frequencies where equivalent LC filters are difficult to construct. They are often called notch filters because a plot of the attenuation or response leads to a typical V-shaped curve. (*From new 4-page Bulletin* 500, *White Instrument Labs.*, 203 *Riverside Dr., Austin* 4, *Texas.*)

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Recording Oscillograph

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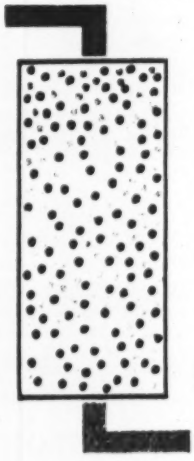
For this literature circle **407** on inquiry card.

Mixed-bed Demineralizers

A mixed-bed or single-column demineralizer employs one resin bed in which the cation and anion resins are thoroughly mixed. While flowing through the bed, the water alternately contacts countless numbers of cation and anion resin particles. This contact with the intimately mixed resins produces demineralized water of high purity. Ionizable impurity content may be held to less than 1 part per million. Water of very high electrical resistance—invariably higher than that obtained with other types of demineralizers—can be produced; resistance is often as high as 20,000,000 ohms per cc. An advantage of the Mixed-Bed Demineralizer for some applications is that the pH stays nearly constant at 7 throughout the cycle. (*From new 20-page Catalog 127, Barnstead Still & Sterilizer Co., 244 Lanesville Terrace, Forest Hills, Boston, Mass.*)



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By-pass Flowmeters

The Ori-Flowrator meter (kinetic manometer) extends the advantages of the Flowrator meter to large pipe sizes and high capacities. This kinetic manometer utilizes the principle of measuring by-pass flow rather than the static differential across a set of orifice taps. Since the by-pass flow and the main line flow are proportional in the first degree, the common problem of a square-root scale is eliminated and a linear, wide range (10 to 1) scale is used. Seal pots or overload checks are unnecessary because the fluid from the main line passes *through* the meter. The by-pass flow acts as a constant purge and does away with the need for a purge liquid or gas in the system. (*From new 20-page Catalog 2, Fischer & Porter Co., Hatboro, Pa.*)

For this literature circle **409** on inquiry card.

Resonant-reed Frequency-sensitive Relays

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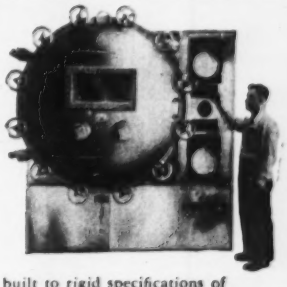

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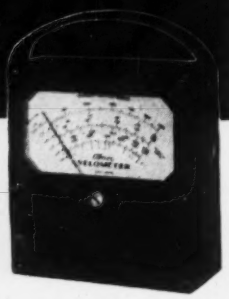

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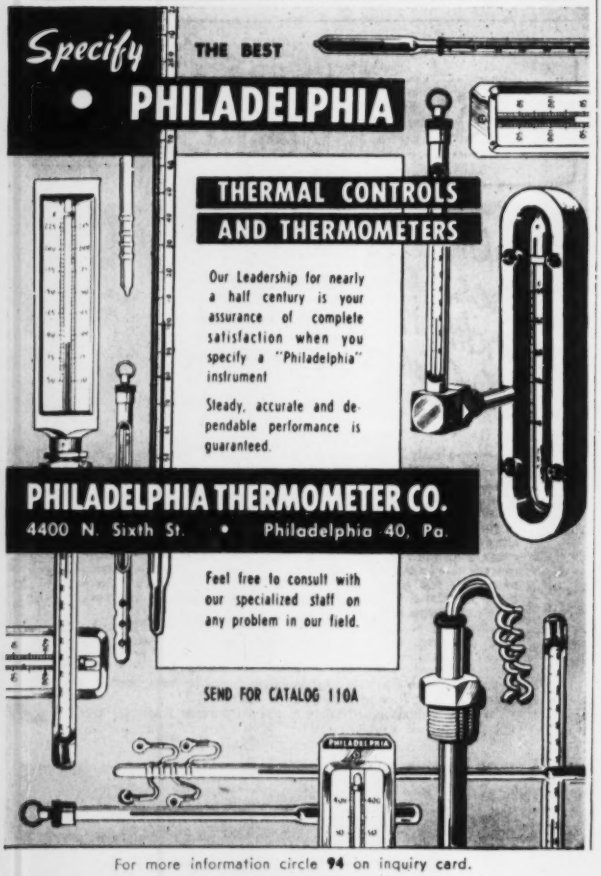

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BRIEFS—CONTINUED

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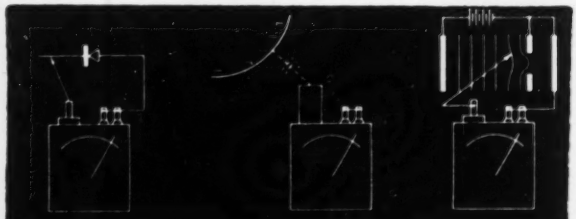

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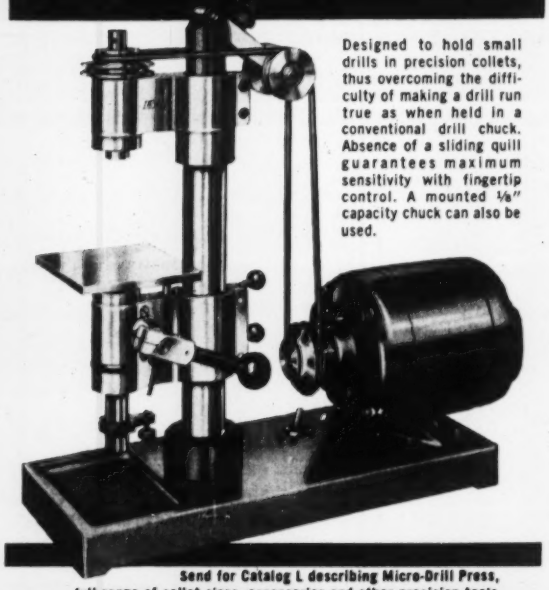

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ance, the voltages on charged capacitors, piezoelectric potentials, surface contact potentials, charge distribution on insulators and voltages of small batteries or grid bias cells. They can also be used as balance indicators in high resistance bridge circuits and to detect the presence of electrostatic fields. Electrometers easily measure currents as low as 10^{-14} ampere. *(From new 8-page brochure, Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.)*

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Spark Suppression Nomograph

When the Millisec Relay is connected to an inductive or a capacitive load, a spark suppression circuit is required to protect the contacts. None is required with a pure resistive load.

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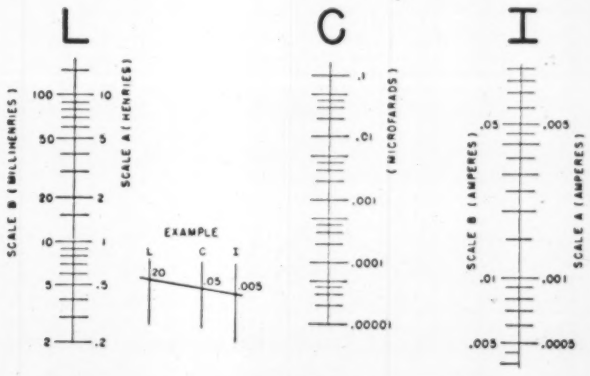

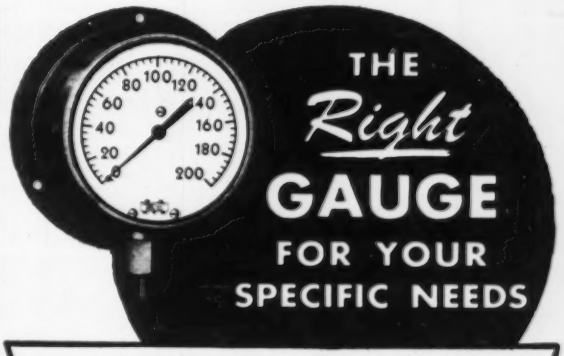

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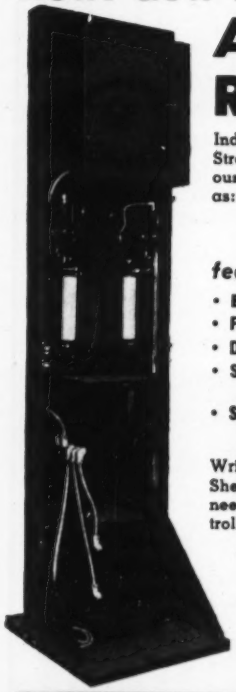
For more information circle **97** on inquiry card.

New! Gow-Mac Gas Purity ANALYZER-RECORDER



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ADVANCE IN HARDNESS TESTING with the NEW DURIMET HARDNESS TESTER

Even the most delicate and highly finished parts or tools may be tested for hardness WITHOUT DAMAGING or DEFORMING THE FINEST FINISH.

The diamond impressions (invisible to the naked eye) are produced with loads of only 15 to 300 grams.

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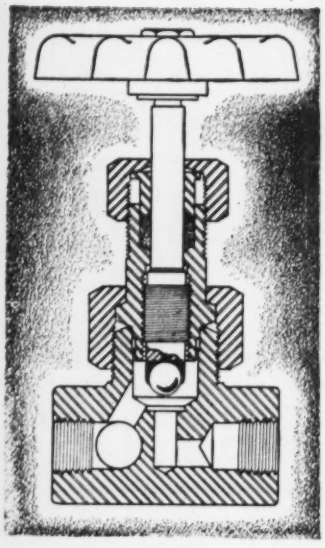
NEW!
BALL VALVE
for air lines, meter manifolds, pressure gauges, other services



Here's a radically-new forged steel valve that can't leak . . . practically never wears out . . . costs less than ordinary steel valves.

In place of a disc or plug, the new Foxboro Ball Valve has a retained, free-rolling stainless steel ball that exposes new surface to seat at every closing.

Foxboro Ball Valves handle pressures to 3000 psi. Available in straight-thru and angle types. Two or four connections to simplify piping. ¼" size. Write for detailed folder. **The Foxboro Company, 467 Neponset Ave., Foxboro, Mass., U.S.A.**

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For more information circle **99** on inquiry card.

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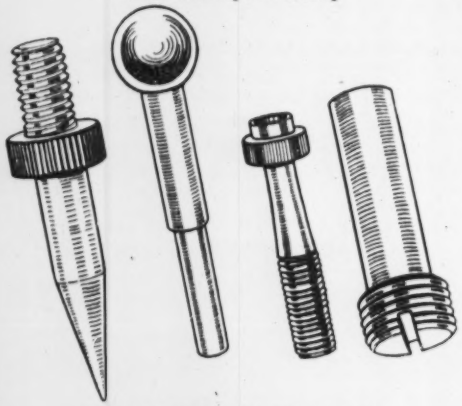

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For more information circle **100** on inquiry card.

BRIEFS—CONTINUED

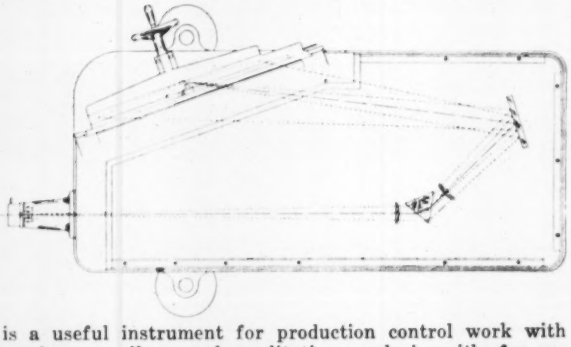
the energy stored in an inductive or capacitive load will surge back and damage the contacts unless they are protected with a spark suppressor.

The spark suppression circuit consists of a capacitor and a resistor connected in series across the Millisec Relay contacts. The value of capacitance may be obtained from the Nomograph, and the resistance calculated. (*From new 8-page Bulletin* 337-329, *Stevens-Arnold, Inc., 22 Elkins St., South Boston, Mass.*

For this literature circle **412** on inquiry card.

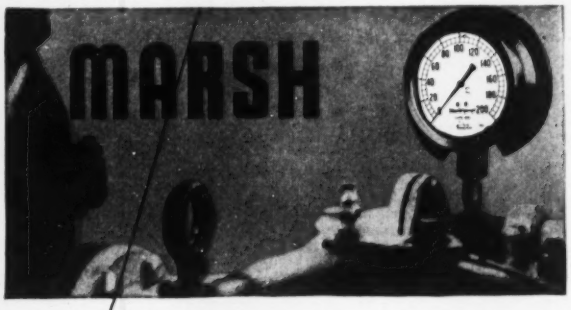
Two-lens Quartz Spectrograph

The "L251-15" Intermediate Quartz Spectrograph is designed for work with emmission and absorption spectra, and



is a useful instrument for production control work with nonferrous alloys and qualitative analysis with ferrous alloys. Provides photographs of the spectrum from 2100 to 10,000 Angstroms on a 14-inch plate and gives coverage from 2100 to 3500 Angstroms on a 10-inch plate. (*From new 2-page brochure, The Gaertner Scientific Corp.,* 1201 *Wrightwood Ave., Chicago* 14, *Ill.*)

For this literature circle **413** on inquiry card.



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For more information circle **101** on inquiry card.

Meniscus Reader

New development for reading length of fat column in Babcock tests. Under black light, fat column fluoresces, making top and bottom menisci clearly visible. (*From new brochure by Vogel Luminescence Corp., 925 Harrison St., San Francisco, Calif.*)

For this literature circle **414** on inquiry card.

Temperature-limited Diodes

These diodes have temperature-limited emission characteristics where the anode current is a direct function of filament voltage. Small changes in filament voltage results in relatively large changes in anode current. (*From new 4-page "Kalotron" brochure, Thermosen, Inc., 361 W. Main St., Stamford, Conn.*)

For this literature circle **415** on inquiry card.

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Opportunity for an engineer to fill responsible position in the design of automotive instruments, industrial temperature gages, recorders and controllers. Should have about 10 years' experience and will have the responsibility of handling redesigning of present products and the designing of new units to be added to the line of automotive and aircraft instruments.

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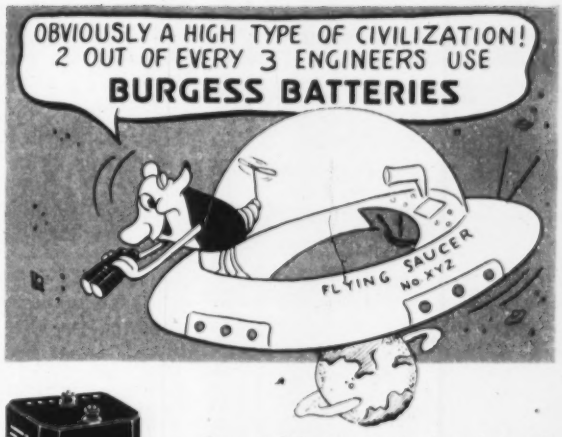

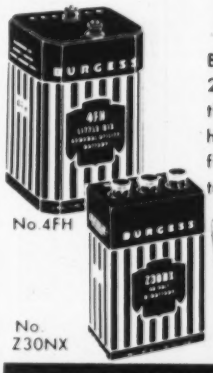

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For more information circle **103** on inquiry card.

Expensive GAGES

Sprague Shut Off Valves automatically cut out gages and other pressure-sensitive instruments when fluid pressures go beyond their operating limits. Automatically open when pressure is again within approx. 80% of set cut-out points. Available for any pressure setting between 10 PSI and 5000 PSI.

Save valuable man hours. Eliminate opening and closing manually operated shut off valves. Supplied with standard pipe thread connections, also available with AN tube fittings. Body is 1½" aluminum hexagon stock. Length 5½". Bronze or stainless steel bodies also available. Easy to install. Thousands in use. Write for bulletin.

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For more information circle **104** on inquiry card.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1113.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Machine-tool Control. New 6-page Bulletin GEA-6122 describes all-electric tracer-control system for automatic control of one or more machine motions.—General Electric Co., Schenectady 5, N. Y.

Circle **416** on inquiry card.

Industrial Instrumentation. New 16-page issue of "CEC Recordings" (Vol. 8 No. 1) contains eight articles on industrial applications of instruments including oscillographs, spectrometers, gyroscopes, digital computers, etc.—Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Calif.

Circle **417** on inquiry card.

Control Instruments. New 8-page issue of "Modern Precision" (Vol. 14 No. 1) contains articles on applications of maker's control instruments in power, metal and ceramics industries, and in research, teaching and testing.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **418** on inquiry card.

Control Systems. New Broadside N 1240-454 describes and illustrates maker's control systems, measuring instruments and primary elements. Includes electric, program, pneumatic and integrated control systems; also applications in chemical, ceramic, and iron and steel industries.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **419** on inquiry card.

Process Instrumentation. New 4-page issue of "Ratonews" (Vol. 3 No. 4) presents articles on automatic, continuous starch cooker and on-off controller.—Fischer & Porter Co., Hatboro, Pa.

Circle **420** on inquiry card.

Magnetic-amplifier Servo Systems. New 2-page brochure presents new magnetic-amplifier plus 2-phase servomotor combinations. Also lists synchros, control transformers, etc.—Ketay Mfg. Corp., 555 Broadway, New York 12, N. Y.

Circle **421** on inquiry card.

Pneumatic-controlled Motor Drive. New 6-page Bulletin M-542 presents maker's "Auto-Pneumatic" controller which features electric-motor-driven output shaft whose speed is proportional to a 3-15-psi. input signal.—Reeves Instrument Co., 215 E. 91 St., New York 28, N. Y.

Circle **422** on inquiry card.

Mechanical Control. New 12-page Bulletin 500 presents maker's mechanical controls, linkages and mechanisms, and illustrates applications.—Teleflex Inc., 125 South Main St., North Wales 4, Pa.

Circle **423** on inquiry card.

Mechanical Controls. New 2-page illustrated Bulletin 32 explains applications for maker's new miniature rigid push-pull controls.—Arens Controls, Inc., 2017 Greenleaf St., Evanston, Ill.

Circle **424** on inquiry card.

Combustion Control. New 2-page Bulletin M presents maker's valves, cocks, blast gates and governors for combustion control.—Eclipse Fuel Engineering Co., Rockford, Ill.

Circle **425** on inquiry card.

Hydraulic Control. New 12-page Bulletin 54-66 pictures and describes maker's hydraulic control and power equipment for textile industry.—Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

Circle **426** on inquiry card.

MOTORS

Motor Drives. New 20-page Bulletin GEA-6127 describes applications of maker's packaged speed-variator motor drives from 1 to 200 hp.—General Electric, Schenectady 5, N. Y.

Circle **427** on inquiry card.

Motor Speed Control. New 8-page brochure describes and illustrates maker's electronic control drive for variable-speed-motors.—Electro Devices Inc., 4-6 Godwin Ave., Patterson 1, N. J.

Circle **428** on inquiry card.

Hysteresis Motor. New 2-page Bulletin 403-1A presents advantages, specifications and diagrams of maker's "inside-out" hysteresis motor.—Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.

Circle **429** on inquiry card.

VALVES

Solenoid Valves. New 4-page Bulletin HP 201 lists features of maker's high-pressure solenoid valves for pressures to 5000 psi.—Atkomatic Valve Co., Inc., 545 West Abbott St., Indianapolis 25, Ind.

Circle **430** on inquiry card.

Automatic Valves. New 2-page Bulletin 1 describes maker's "Type RHV" revolving-head, automatic-reseating temperature- and pressure-relief valves.—A. W. Cash Valve Mfg. Corp., 666 E. Wabash Ave., Decatur, Ill.

Circle **431** on inquiry card.

Valves, Level Gages. New 2-page Data Unit 238 illustrates variety of connections available with maker's gages and valves.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Mass.

Circle **432** on inquiry card.

Hydraulic Valves. New 8-page Catalog Section 260 pictures and describes maker's solenoid-operated sub-plate-mounted hydraulic valves.—Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.

Circle **433** on inquiry card.

Cylinder-tap Valve. New 4-page bulletin describes maker's new "Type D532" cylinder-top valve. Two 2-page brochures present photographs, diagrams and characteristics.—Emmett Machine & Mfg., Inc., 2249 14th St., S. W., Akron 14, Ohio.

Circle **434** on inquiry card.

Valves. New 52-page Catalog 500 illustrates and describes maker's line of two- and three-way valves, including fluid-pressure and electrically-actuated models.—Marotta Valve Corp., Boonton, N. J.

Circle **435** on inquiry card.

Replacement Valve Bodies. New 2-page Bulletin 345 illustrates and describes maker's "Type 1000" flanged and "Type 2000" slip-over-pipe replacement pinch-valve bodies.—General Rubber Corp., Tenafly, N. J.

Circle **436** on inquiry card.

Ball Valves. New 8-page illustrated Bulletin 159 describes maker's manually-operated ball valves in sizes from 12 inches to 48 inches for shut-off service at pressures up to 150 psi.—S. Morgan Smith Co., York, Pa.

Circle **437** on inquiry card.

Shut-off Valve. New 4-page brochure lists construction features, and specifications of maker's safety shut-off valve which checks fuel-fed fires.—Valco Inc., 1410 West St., Cincinnati 15, Ohio.

Circle **438** on inquiry card.

TEMPERATURE

Temperature Control. New 2-page Bulletin F-971 lists features, applications, and specifications of maker's "Series 97" electronic temperature control.—Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.

Circle **439** on inquiry card.

Temperature Chart. New pocket-size chart presents Fahrenheit and Centigrade temperature-conversion table.—Moeller Instrument Co., 132nd St. and 89th Ave., Richmond Hill 18, N. Y.

Circle **440** on inquiry card.

Thermal Radiometers. New 2-page Bulletin 188 describes two "Model 188" series portable radiometers for total-hemispherical thermal-radiation measurements and net-exchange measurements.—Beckman & Whitley Inc., 930 E. San Carlos Ave., San Carlos, Calif.

Circle **441** on inquiry card.

Heat-flow Transducer. New 2-page Bulletin 200-1053 presents description and specifications of maker's climate-survey heat-flow transducers.—Beckman & Whitley Inc., 985 San Carlos Ave., San Carlos, Calif.

Circle **442** on inquiry card.

Resistance Thermometer Regulator. New 2-page bulletin describes maker's "Resiregs" resistance thermometer regulators with range from −450 to 3,000 F.—Weiller Instruments Corp., 95 Broad St., New York 4, N. Y.

Circle **443** on inquiry card.

Temperature Control. New 2-page Bulletin 103 pictures and describes maker's "Models B-1C and B-1X" for controlling temperatures or use as safety alarms and cut-outs.—Burling Instrument Co., Inc., 16 River Rd., Chatham, N. J.

Circle **444** on inquiry card.

Thermoelements. New 6-page illustrated brochure describes maker's noble- and base-metal thermoelements. —Charles Engelhard, Inc., 850 Passaic Ave., East Newark, N. J.

Circle **445** on inquiry card.

Low-temperature Apparatus. New 14-page catalog presents maker's low-temperature apparatus. Includes discharge devices, open dewar flasks, storage and transport containers, etc. —Hofman Laboratories Inc., 219-221 Emmet St., Newark 5, N. J.

Circle **446** on inquiry card.

PRESSURE

Pressure Transducers. New 12-page Bulletin PT-1 presents maker's pressure transducers for converting dynamic or static pressure into electrical signals.—Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.

Circle **447** on inquiry card.

Rupture Discs. New 8-page illustrated brochure explains uses and applications of maker's precious-metal rupture discs for instant automatic release of excess pressure.—Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

Circle **448** on inquiry card.

Vacuum Manifold System. New 2-page Bulletin 4-90 covers operation, installation and specifications of maker's "Type SE-59" 10-port vacuum manifold system for evacuating and backfilling small containers ten at a time.—Consolidated Vacuum Corp., Rochester 3, N. Y.

Circle **449** on inquiry card.

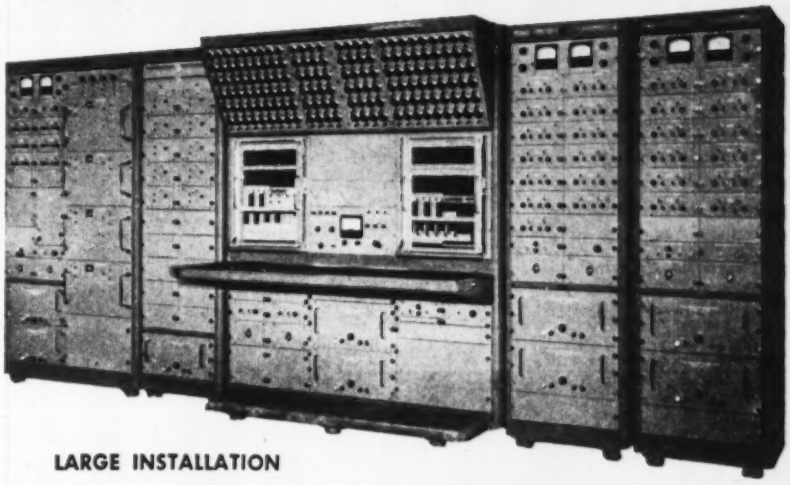
Oil-diffusion Pumps. New 8-page Data Sheet 6-55 presents description, illustrations and specifications of maker's "Type MCF" fractionating oil-diffusion pumps.—Consolidated Vacuum Corp., Rochester 3, N. Y.

Circle **450** on inquiry card.

Pressure, Tension. New 8-page Bulletin PP 1-50-10M describes and pictures maker's push-pull gages for measuring mechanical tensions and pressures.—John Chatillon & Sons, 85 Cliff St., New York 7, N. Y.

Circle **451** on inquiry card.

MODERN Problems Demand ... MODERN SOLUTIONS

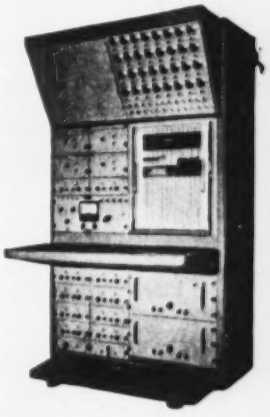


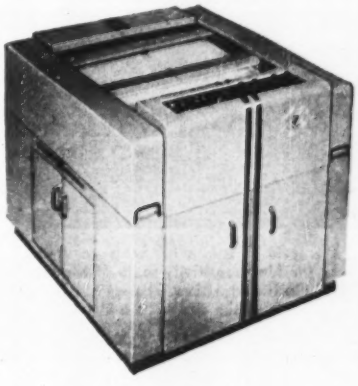
LARGE INSTALLATION

This large computer is used for the rapid solution of aero-dynamic problems. It consists of 50 operational amplifiers, 10 servo multiplying channels, 4 resolving channels, and a control console with two pre-patch bays, 156 attenuators, two voltmeters, and all necessary operational controls

SINGLE PACKAGE COMPUTER

Our Type 16-31R Computer is a single package computer capable of solving differential equations with many simultaneous elements which are often encountered in the simulation of dynamic systems. It contains 20 operational amplifiers, 4 servo multipliers, thirty-two attenuators, all-metal removable problem board, and complete control panel.





PLOTTING EQUIPMENT

For presentation of problem solutions, the Variplotter Plotting Boards provide an accurate inked record. Typical uses include the automatic plotting of: Analog Computer output; guided missile data; engine performance characteristics; and control of manufacturing processes. With accessory equipment the range of applications can be greatly extended.

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ELECTRONIC ASSOCIATES Incorporated

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For more information circle **105** on inquiry card.

HEISE GAUGES

The high standard of excellence maintained by Heise qualifies this instrument for the most exacting requirements. Consistently accurate performance as a calibration reference has established its recognition as

THE STANDARD OF THE WORLD

★ Permanent, positive accuracy of alignment guaranteed by integral construction.

★ Weldless heat treated Bourdon tube maintains precise calibration.

★ Dial individually engraved with reference to the pressure gradient of its gauge mechanism.

★ Patented "External Bleeder" permits rapid, efficient evacuation of air or gasses.

Pressures to 20,000 psi. Sizes: 8½", 12" and 16"
Prices from $151.60

HEISE BOURDON TUBE COMPANY, INC.
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High Precision Optical Components Any Size For Astronomical and Physical Research

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Parabolic, Spherical, Ellipsoidal and Plane Mirrors

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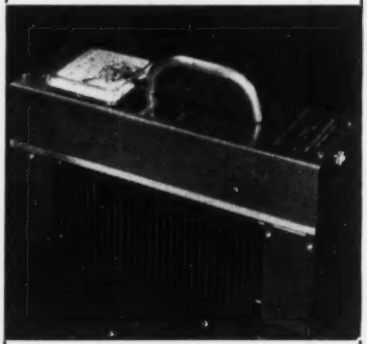
MERCURY VAPOR DETECTOR

for detecting the toxic vapor given off by mercury



The toxic limit is a full scale reading on the high sensitivity scale of Model 23, illustrated above. The weight is 7 pounds and the size is 13 x 8½ x 4½ inches.

A bibliography on the mercury vapor hazard is available on request as well as literature on the different models of the Kruger Mercury Vapor Meter.

HAROLD KRUGER INSTRUMENTS
Box 164 San Gabriel, Calif.

For more information circle **108** on inquiry card.

NEW LITERATURE

FLOW

Pumps. New 8-page catalog presents description, operation and application of maker's pumps for forcing liquids, solutions or gases through tubing.—Sigmamotor, Inc., 3 North Main St., Middleport, N. Y.
Circle **452** on inquiry card.

Flow, Water Treatment. New 8-page Bulletin 100-L5 is reprint describing application of Venturi tubes to measuring flow of gas at large volumes or at low pressure and compares it with orifice-plate installation; 16-page Bulletin 100-K2 describes instrumentation and control of water-treatment and complete line of equipment for water-treatment plants.—Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.
Circle **453** on inquiry card.

Proportional Mixers. New 4-page Bulletin L illustrates and describes maker's line of air/gas proportional mixers.—Eclipse Fuel Engineering Co., 1001 Buchanan St., Rockford, Ill.
Circle **454** on inquiry card.

WEIGHT

Weigh Feeder. New 4-page Bulletin 3288 presents description and specifications of maker's weigh feeder for injection-molding machines; 4-page reprint discusses weigh-feeding process.—Exact Weight Scale Co., Columbus 8, Ohio.
Circle **455** on inquiry card.

Loss-in-weight Recorder. New 2-page Bulletin 50-L13 pictures and describes maker's loss-in-weight indicator-recorder for use with volumetric dry feeders.—Omega Machine Co., 345 Harris Ave., Providence 1, R. I.
Circle **456** on inquiry card.

Solution Balance. New illustrated folder lists features and specifications of maker's heavy-duty solution balance and accessories.—Ohaus Scale Corp., Union, N. J.
Circle **457** on inquiry card.

Industrial Scales. New illustrated brochure presents maker's industrial scales and force-measuring devices.—John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.
Circle **458** on inquiry card.

COMPUTERS

Computers, Components. New 12-page illustrated brochure describes and illustrates maker's electronic computers and plug-in components.—Servomechanisms, Inc., 316 Washington St., El Segundo, Calif.
Circle **459** on inquiry card.

Analog Computer. New 20-page illustrated brochure "Ready Room" presents reprints describing maker's products, capabilities and facilities, also describes and illustrates maker's "GEDA" electronic differential analyzer.—Goodyear Aircraft Corp., Akron 15, Ohio.
Circle **460** on inquiry card.

Computer Components. New 8-page catalog illustrates and describes maker's line of computer components and packaged servo systems.—Feedback Controls Inc., 503 Rhode Island Ave., Washington 2, D. C.

Circle **461** on inquiry card.

Punched Cards. New 6-page Bulletin TM-817 describes maker's "Multi-Control" reproducing punch which performs feeding, sensing, computing, punching, segregating and interfiling functions in one operation.—Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.

Circle **462** on inquiry card.

Magnetic-core Analyzer. New 14-page brochure describes maker's "Model MPT-1" magnetic-core pulse analyzer and its use in testing cores for high-speed memories in digital computers.—Rese Engineering Inc., 301 Walnut St., Phila. 6, Pa.

Circle **463** on inquiry card.

RECORDING

Tape Recorder. New 4-page Bulletin AB3-1-3 presents features, performance characteristics and specifications of maker's "Model 600" portable magnetic-tape recorder.—Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle **464** on inquiry card.

Operational Recorder. New 2-page illustrated bulletin presents features, operation, and circuit data on device for process timing, multiple recording.—Librascope, Inc., 1607 Flower St., Glendale, Calif.

Circle **465** on inquiry card.

Oscillograph. New 2-page illustrated brochure describes maker's new "Type 323" cathode-ray oscillograph.—Allen B. Du Mont Laboratories Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **466** on inquiry card.

TIMING

Process Timer. New 8-page Bulletin GEC-1223 covers operation advantages and applications of maker's new "Type TSA-18" process timer.—General Electric Co. Schenectady 5, N. Y.

Circle **467** on inquiry card.

Fractional Cycle Timer. New 2-page bulletin describes maker's "Model F-216" fractional cycle timer for resistance welding.—Vacuum Tube Products, 506 South Cleveland St., Oceanside, Calif.

Circle **468** on inquiry card.

Stop Watches. New 6-page illustrated brochure presents distributor's line of stop watches, chronograph watches and time study boards.—Celebar Watch Agency, 521 Fifth Ave., New York 17, N. Y.

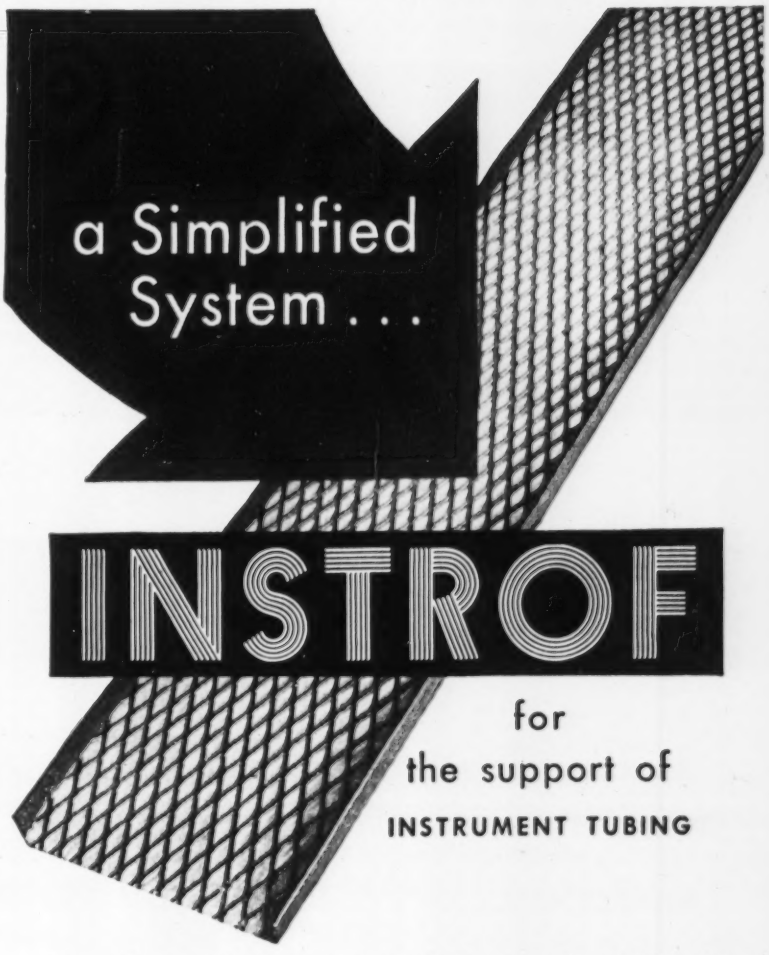
Circle **469** on inquiry card.

RADIOACTIVITY

Radioactivity Detection. New 4-page bulletin pictures and describes maker's new "Rad-Tek" for detection of radioactivity.—El-Tronics, Inc., Fifth and Nobel Sts., Phila. 23, Pa.

Circle **470** on inquiry card.

X-ray. New 8-page issue of "Radiation Digest" contains articles on in-



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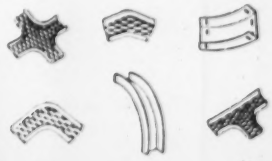

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NEW LITERATURE

dustrial and scientific applications of x-rays.—X-Ray Dept., General Electric Co., Milwaukee 14, Wis.
Circle **471** on inquiry card.

Radioactivity Instruments. New 16-page catalog describes and illustrates maker's radiation instruments for laboratories, civil defense, universities and industry.—Professional Instrument Corp., 149 Broadway, New York, N. Y.
Circle **472** on inquiry card.

HUMIDITY

Moisture Measurement. New 6-page illustrated Bulletin 2051 lists features and advantages of maker's "Dewpointer" for determination of dew points, and water-vapor density and pressure.—Illinois Testing Laboratories, Inc., 420 North LaSalle St., Chicago 10, Ill.
Circle **473** on inquiry card.

Moisture Measurement. New 4-page brochure describes and illustrates maker's "Supertest 712" moisture-measuring instrument.—Hygrotester Inc., Brooklyn 1, N. Y.
Circle **474** on inquiry card.

ACCELERATION, VIBRATION

Linear Accelerometers. New 4-page Bulletins AT-1 and AL-1 present descriptions and specifications of maker's linear accelerometers.—Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.
Circle **475** on inquiry card.

Vibration Analyzers. New 16-page illustrated Bulletin G-1 presents maker's line of portable vibration-analysis equipment and discusses typical applications.—International Research & Development Corp., 168 East Hosack St., Columbus 7, Ohio.
Circle **476** on inquiry card.

Vibration Mounting. New 2-page semi-monthly issues of "Vibration and Shock Control Trends" contain illustrations and detailed information on latest models of mountings and equipment installations.—Robinson Aviation, Inc., Teterboro, N. J.
Circle **477** on inquiry card.

TESTING, INSPECTION

Testing. New 4-page issue of "Instrument News" (Vol. 10 No. 2) contains articles on testing and descriptions of maker's electrical testing instruments, including resistance testers.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.
Circle **478** on inquiry card.

Spring Testers. New 6-page illustrated folder presents description and specifications of maker's precision spring testers in all capacities from 200 grams.—John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.
Circle **479** on inquiry card.

Testing Instruments. New 58-page 1954 Catalog describes maker's testing instruments for paint and similar industries, including glossmeters, appearance-measuring instruments, paint conditioners, etc.—Gardner Laboratory, Inc., Bethesda, Md.
Circle **480** on inquiry card.

High-potential Testing. New 2-page Bulletin 14-1 outlines advantages and applications of maker's d-c. high-potential "Hypot" testing units.—Associated Research, Inc., 3767 West Belmont Ave., Chicago, Ill.
Circle **481** on inquiry card.

Coordinate Comparator. New 2-page Bulletin 169-54 describes maker's "M1229" coordinate comparator for measurement and evaluation of photographic records, and inspection and measurement of small mechanical parts.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.
Circle **482** on inquiry card.

Fatigue Machine. New 2-page bulletin 4214 presents elevated-temperature testing, operation principles, and specifications of maker's "Model SF-4" fatigue machine.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.
Circle **483** on inquiry card.

GAGING

Caliper, Height Gage. New 2-page bulletin describes and illustrates maker's vernier calipers, height and depth gages.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.
Circle **484** on inquiry card.

Electron Micrometer. New 4-page bulletin and 4-page insert illustrate

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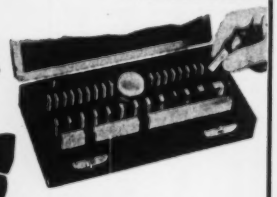

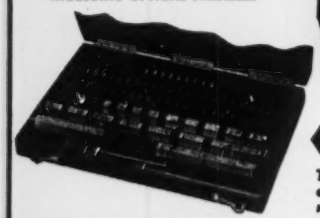

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and describe maker's electron-micrometer yarn-evenness tester.—Standard Electronics Research Corp., 2 East End Ave., New York 21, N. Y.

Circle **485** on inquiry card.

Micrometers. New 2-page illustrated bulletin gives specifications on line of foreign-made micrometers. Includes screw pitch, precision, and adjustable micrometers and accessories.—De Witt Equipment Corp., Lafayette St., New York 13, N. Y.

Circle **486** on inquiry card.

Turret Stop Indicator. New 4-page illustrated bulletin describes maker's "Sure-Stop" turret stop indicator for maintaining close length tolerances in the duplication of machined parts. —D-S-C Machine Co., 29 Bertel Ave., Mount Vernon, N. Y.

Circle **487** on inquiry card.

Groove Gages. New 4-page Catalog 54D illustrates and describes maker's line of snap-ring groove gages for dimensional control of internal snap-ring grooves.—Reliant Industries, 4947 Firestone Blvd., South Gate, Calif.

Circle **488** on inquiry card.

Micrometer. New set of bulletins describe diameter measurement with maker's "Diamatrol" electronic micrometer, and diameter control with "Diamacontrol".—Standard Electronics Research Corp., 2 East End Ave., New York 21, N. Y.

Circle **489** on inquiry card.

ANALYTICAL

pH Electrodes. New 20-page Catalog EN-S5 covers maker's electrodes, chemicals for electrode servicing, and auxiliary electrode equipment such as clamps, holders, thermometers.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **490** on inquiry card.

Spectrochemical Analysis. New 8-page Catalog V3-54 describes maker's "Varisource," all-in-one excitation unit for spectrochemical analysis.—Jarrell-Ash Co., Newtonville, Mass.

Circle **491** on inquiry card.

Gas Analysis. New 2-page illustrated Data Sheet 10. 15-12 presents theory, operation and applications for sensitive gas analyzers and recorders. —Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **492** on inquiry card.

Spectroscopic Electrodes. New 4-page Catalog Section A-4004 presents maker's preformed graphite spectroscopic electrodes, including diagrams and technical references.—National Carbon Co., 30 East 42nd St., New York 17, N. Y.

Circle **493** on inquiry card.

Gas Samplers. New 6-page folder presents description and operating principles of maker's continuous gas samplers.—E. K. Von Brand, Hopewell Junction, N. Y.

Circle **494** on inquiry card.

LAB APPARATUS

Lab Apparatus. New 64-page catalog presents descriptions, and illustrations of new items that have been added to maker's line of scientific in-

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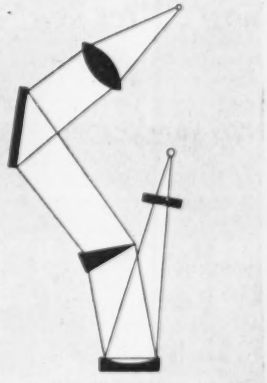

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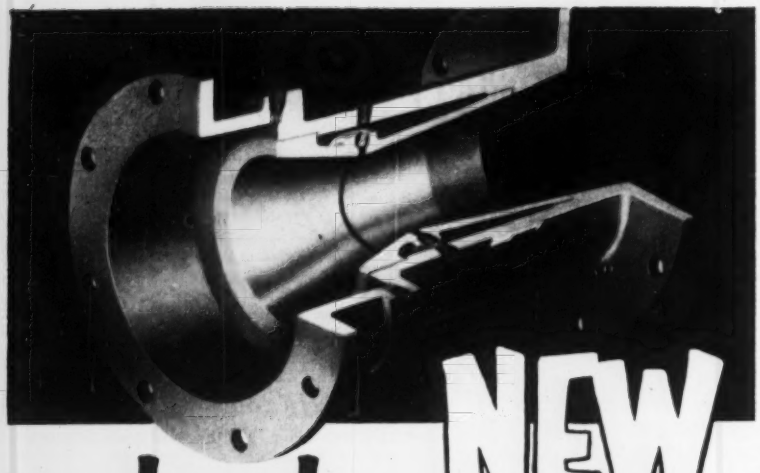

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NEW LITERATURE

struments and apparatus.—Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

Circle **495** on inquiry card.

Lab Equipment. New 28-page issue of "Scientific Methods" (Vol. 6 No. 2) illustrates and describes maker's laboratory instruments, apparatus, supplies and chemicals.—E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.

Circle **496** on inquiry card.

Constant-temperature Ovens. New 34-page Catalog 331A illustrates and describes maker's constant-temperature ovens, incubators and accessories. New 2-page Bulletin 715 presents new "Lo-Cap" heater for distillation shields.—Precision Scientific Co., 3737 West Cortland St., Chicago 47, Ill.

Circle **497** on inquiry card.

Constant-temperature Baths. New 4-page Bulletin 666 pictures and describes maker's "Sero-Utility" constant-temperature baths.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **498** on inquiry card.

Minitube Mill. New 4-page "Newsletter" Vol. 1, No. 5 describes maker's portable minitube mill and "Model 105" four-gang washability machine. —Gardner Laboratory Inc., 4723 Elm St., Bethesda 14, Md.

Circle **499** on inquiry card.

Laboratory Equipment. New 12-page catalog describes and illustrates maker's 40 types and sizes of aluminum-alloy laboratory clamps. New 4-page Bulletin 702 presents maker's line of "Lab-Rooms," constant-temperature rooms.—Labline Inc., 217 North Desplaines St., Chicago 6, Ill.

Circle **500** on inquiry card.

Lab Ovens. New 4-page Bulletin 3500 pictures and describes maker's radiant-wall and thermo-wall ovens for laboratory and plant use.—Labline Inc., 217 North Desplaines St., Chicago 6, Ill.

Circle **501** on inquiry card.

Combustion-tube Furnace. New 2-page Bulletin 254 covers construction, uses, temperature range and control, and specifications of maker's high-temperature combustion-tube furnaces.—Hevi Duty Electric Co., Milwaukee 1, Wis.

Circle **502** on inquiry card.

Lab Furnaces. New 4-page Bulletin 1153 describes "Blue M" electric ovens and furnaces and related equipment available from—Boder Scientific Co., 719 Liberty Ave., Pittsburgh 22, Pa.

Circle **503** on inquiry card.

OPTICAL

Spectra Instruments. New 4-page brochure describes and illustrates spectra instruments for control of color photography and processing.—Photo Research Corp., 127 West Alameda Ave., Burbank, Calif.

Circle **504** on inquiry card.

Photographic Materials. New 16-page Catalog F1-29 presents maker's

films, plates, pellicles, filters and wedges for scientific work.—Eastman Kodak Co., Rochester 4, N. Y.

Circle **505** on inquiry card.

Tristimulus Colorimeters. New 2-page bulletin presents description and diagrams of maker's tristimulus colorimeters for TV picture tubes.—Hunter Associates Laboratory, 5421 Brier Ridge Road, Falls Church, Va.

Circle **506** on inquiry card.

Closed-Circuit TV System. New illustrated Brochure 3R2335 describes 20 applications of maker's "TV Eye" closed-circuit television equipment.—Engineering Products Div., RCA, Camden, N. J.

Circle **507** on inquiry card.

Gage Illuminators. New 2-page Data Unit 242 describes, illustrates and gives specifications of maker's illuminators for liquid-level gages.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Mass.

Circle **508** on inquiry card.

ATMOSPHERE

Atmospheric Pollution. New 8-page Booklet IH illustrates and describes maker's wind-direction-and-speed instruments, precipitation gages, testing instruments, current meters and water-level gages and recorders for reducing industrial pollution.—W. & L. E. Gurley, Troy, N. Y.

Circle **509** on inquiry card.

Mercury Vapor Meter. New 2-page bulletin lists features and operation of maker's portable mercury-vapor meter for surveying room atmosphere. —Harold Kruger Instruments, P. O. Box 164, San Gabriel, Calif.

Circle **510** on inquiry card.

SEISMOLOGY

Seismic Exploration. New 4-page illustrated brochure describes maker's truck-mounted seismic recorder, and magnetic reproducer for field stations. —Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **511** on inquiry card.

AIRCRAFT INSTRUMENTS

Ice-detection Systems. New 8-page issue of "Cook Diaphlex Newsletter" (Vol. 1 No. 25) outlines maker's improved ice-detection system for aircraft.—Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

Circle **512** on inquiry card.

Vertical Gyro Indicator. New 2-page Bulletin 1-1 presents description, application, and performance of maker's "Model 978-K" pictorial vertical gyro indicator.—Lear, Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

Circle **513** on inquiry card.

Aircraft Equipment. New 36-page Catalog 21d describes and illustrates maker's batteries, lights, switches, wiring, electrical connectors, etc. for use in aircraft.—Air Associates, Inc., Teterboro, N. J.

Circle **514** on inquiry card.

FREQUENCY, PHASE

Frequency Counter. New 8-page issue of "hp Journal" (Vol. 5 No. 7-8) features article on "Model 524B" 10-megacycle frequency counter.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **515** on inquiry card.

Indicating Instruments. New 48-page Catalog 28 describes and illustrates maker's electrical indicating instruments, including frequency meters, current transformers, ammeters, microammeters, voltmeters, etc.—Hickok Electrical Instrument Co., 10514 Dupont Avenue, Cleveland 8, Ohio.

Circle **516** on inquiry card.

Sine-wave Generator. New 2-page Catalog sheet describes and pictures "305857" generator for frequency synthesis analysis.—Librascope, Inc., 1607 Flower St., Glendale, Calif.

Circle **517** on inquiry card.

Rotation, Phase Tester. New 6-page Bulletin 80 presents maker's motor-rotation and phase tester for determining rotation direction of electric motors before connection to line, and phase rotation or sequence of energized power circuits.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

Circle **518** on inquiry card.

Frequency Meter. New 2-page bulletin presents maker's frequency meter for setting frequency of cw. and mcw. transmitters with voice, tone or other modulation.—Colortone Electronics, Inc., 238 William St., New York, N. Y.

Circle **519** on inquiry card.

Tachometers. New 4-page brochure describes and illustrates distributor's line of foreign-made hand tachometers with jewelled movement.—Clarence J. Marx, 64 E. 207 St., Euclid 23, Ohio.

Circle **520** on inquiry card.

AMPLIFIERS

Electronic Test Instruments. New 4-page Bulletin 105-5-54 presents maker's electronic instruments for precision test measurement. Includes amplifiers, bridge balances, transducers, calibrators, etc.—Wm. Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena 8, Calif.

Circle **521** on inquiry card.

Magnetic Amplifier. New 2-page bulletin describes maker's single-stage magnetic amplifier for educational and experimental purposes.—Electro Methods Ltd., Caxton Way, Stevenage, Herts, England.

Circle **522** on inquiry card.

Plug-in Units. New 12-page Catalog C-3 presents diagrams and mechanical specifications of maker's packaged plug-in circuits.—Electronic Engineering Co. of Calif., 180 South Alvarado St., Los Angeles, Calif.

Circle **523** on inquiry card.

Indicating Amplifier. New 2-page Bulletin 1A pictures and describes maker's d-c. indicating amplifier "Type 2HLA-3" for measurement and amplification.—Doelcam Corp., Soldiers Field Rd., Boston 35, Mass.

Circle **524** on inquiry card.

Detector. 30-Mc. IF Amplifier. New 12-page issue of "General Radio Experimenter" (Vol. 28 No. 12) features article on new, sensitive, high-frequency, general-purpose detector—a 30-Mc. i-f. amplifier.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

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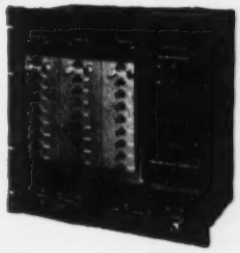

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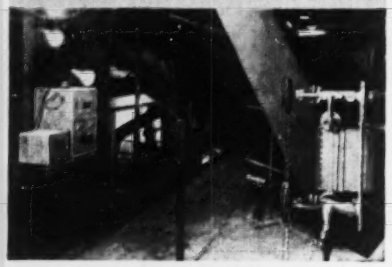

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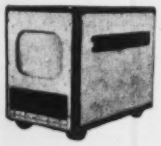

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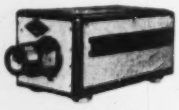

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For more information circle **119** on inquiry card.

NEW LITERATURE

RESISTANCE TESTING

Dielectric Test Set. New 4-page Bulletin 22 presents description and specifications of maker's "Model 1-40 KV" dielectric test set for measuring d-c. up to 40 kv.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.
Circle **526** on inquiry card.

Test Equipment. New 4-page illustrated bulletin lists features and applications of maker's sensitive "Hipot" testers, high-voltage testers, insulation testers, and leakage testers.—Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.
Circle **527** on inquiry card.

Surface-resistance Analyzer. New 2-page bulletin presents description, applications, operation and specifications of maker's new "Model 1653 Tyometer" surface-resistance analyzer for measuring surface resistance of aluminum prior to resistance welding.—Chemical Research Associates, 333 North Michigan Ave., Chicago 1, Ill.
Circle **528** on inquiry card.

POWER SUPPLIES

DC Power Supplies. New 4-page Bulletin MA 154 describes maker's airborne high-voltage power supplies and magnetic-amplifier regulated units.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.
Circle **529** on inquiry card.

Power Supplies. New 4-page illustrated bulletin lists features and specifications of maker's precision regulated power supplies.—Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y.
Circle **530** on inquiry card.

Inverters. New 2-page Bulletins A-H, Catalog 254, 6-page folder, and Form 35402 describe and illustrate maker's inverters for changing storage-battery direct current to a.c.—American Television & Radio Co., St. Paul, Minn.
Circle **531** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Panel Instruments. New 12-page illustrated Bulletin GEC-568F lists construction and application details of maker's d-c. and a-c. panel instruments and accessories.—General Electric, Schenectady 5, N. Y.
Circle **532** on inquiry card.

Telemetering Filters. New 2-page illustrated Bulletin TF lists features of maker's telemetering filters with high-"Q"-toroid inductor elements.—Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif.
Circle **533** on inquiry card.

Electrostatic Neutralizer. New 4-page bulletin lists features and applications of "Magic Wand" electrostatic neutralizer bar.—Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.
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Pulse Generator. New 8-page issue of "General Radio Experimenter" con-

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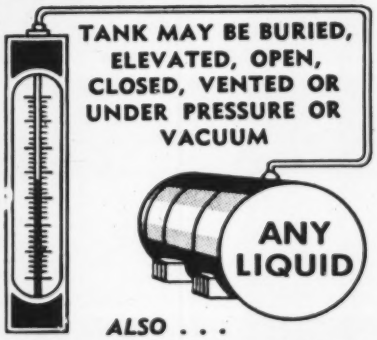

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tains articles on maker's "Type 1217-A" unit pulser and "Variac" as an adjustable-ratio current transformer.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **535** on inquiry card.

Coaxial-line Instruments. New 14-page catalog and 2-page insert illustrates and describes maker's coaxial-line instruments. Includes low-pass filters, wattmeters, load resistors, etc.—Bird Electronic Corp., 1800 East 38 St., Cleveland, Ohio.

Circle **536** on inquiry card.

Unit Pulse Equipment. New 8-page booklet lists construction and specifications of maker's unit pulse equipment, including pulse generators, amplifiers, cathode followers, etc.—A. E. Cawkell, 6-7 Victory Arcade, The Broadway, Southall, England.

Circle **537** on inquiry card.

RESISTORS

High-voltage, High-frequency Resistors. New 8-page Bulletin F-1 presents specifications and applications of maker's "Type MP" high-frequency resistors; 8-page Bulletin G-1 presents "Type MV" high-voltage resistors.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **538** on inquiry card.

Resistors. New 2-page issue of "Ohmite News" features article on completely encapsulated precision resistors. Also describes maker's rotary tap switches, tapped resistors, completely enclosed rheostats and chokes.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.

Circle **539** on inquiry card.

Resistors, Transformers. New 36-page Catalog R 200 presents maker's precision resistors, power resistors, deflection yokes, focus coils and IF and RF transformers and coils.—I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Phila. 30, Pa.

Circle **540** on inquiry card.

Potentiometers. New 2-page Bulletin 3-54 presents descriptions, electrical and mechanical specifications and diagrams of maker's "Model 162", "200" and "300" precision potentiometers.—George Rattray & Co., Inc., 116-08 Myrtle Ave., Richmond Hill 18, N. Y.

Circle **541** on inquiry card.

Resistors. New 2-page Bulletin PR-154 describes and pictures maker's line of wirebound, fixed, non-inductive, precision resistors.—K-F Development Co., Redwood City, Calif.

Circle **542** on inquiry card.

Potentiometers. New 2-page brochure lists features and specifications of maker's "Series HP-300" high-resolution precision potentiometers.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C. 1, N. Y.

Circle **543** on inquiry card.

RELAYS, SWITCHES

Resonant Relays. New 2-page bulletin presents description and principle of operation of maker's resonant relay which operates only when energized at a pre-determined frequency.—Stev-

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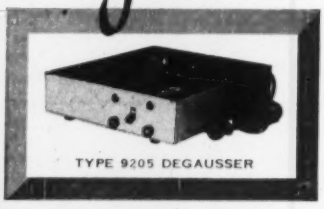

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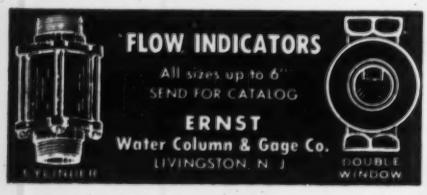

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NEW LITERATURE

ens-Arnold Inc., 22 Elkins St., South Boston 27, Mass.

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Relays. New 44-page Catalog L15-M54 describes and pictures maker's relays including midget, circuit-control, special-purpose, radio and high-frequency aircraft relays.—Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle **545** on inquiry card.

Relays. New 2-page Data Sheet 13100.1 presents description and diagrams of maker's time-delay relays; 16-page and 8-page issues of "Newsletter" describe and illustrate plant facilities and miniature relays.—Neomatic Inc., 9010 Bellanca Ave., Los Angeles 45, Calif.

Circle **546** on inquiry card.

Circuit Breakers. New 24-page Bulletin 201 is engineering guide to application of maker's circuit breakers to protective and control functions.—Heinemann Electric Co., 545 Plum St., Trenton 2, N. J.

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Mercury Relays. New 4-page Catalog 154 presents features, illustrations and specifications of maker's plunger type mercury relays.—Ebert Electronics Corp., Queens Village 28, N. Y.

Circle **548** on inquiry card.

Relays, Synchros, Transformers, Rectifiers. New 16-page May-June issue of "This Month" describes and illustrates distributor's lines of industrial instruments, blowers, electric ovens, transformers, timing devices, switches, rectifiers, etc.—Herbach & Rademan Inc., 1204 Arch St., Phila. 7, Pa.

Circle **549** on inquiry card.

Delay Relays, Pulsers. Two new 2-page bulletins present description and specifications of maker's "Models T-177-A and T-173-A Pulsitometers" electronic timers for airborne applications requiring timed pulses.—Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles 39, Calif.

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Relays. New 8-page Catalog illustrates and describes maker's hermetically-sealed and dust-tight relays.—Magnecraft Electric Co., 1450 W. Van-Buren St., Chicago 7, Ill.

Circle **551** on inquiry card.

Limit Switch. New 4-page Bulletin LS54A describes electrical, mechanical and maintenance characteristics of maker's new heavy-duty limit switch for machine tools.—R. B. Denison Mfg. Co., 102 St. Clair Ave. N. W., Cleveland 13, Ohio.

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TRANSISTORS, TUBES

Silicon Transistors. New 2-page bulletins describe maker's "Types 900" and "901" silicon grown-junction transistors and "X-15" medium-power silicon transistors.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex.

Circle **553** on inquiry card.

Germanium Crystals. New 42-page illustrated booklet discusses industrial uses for germanium crystals in relay, timing circuit, power supply and instrumentation applications. Price 25 cents.—Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

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NAMEPLATES

Nameplates. New 4-page illustrated brochure announces maker's new "Foilcal", self-adhesive nameplates—Miller Dial and Name Plate Co., 4400 North Temple City Blvd., El Monte, Calif.

Circle **555** on inquiry card.

Trims, Panels. New 4-page brochure illustrates use of maker's custom-made decorated metal trims, panels, escutcheons as functional component parts.—American Name Plate & Manufacturing Co., 4254 Arthington St., Chicago 24, Ill.

Circle **556** on inquiry card.

ELECTRONIC COMPONENTS

Electronic Components. New 20-page Catalog 975 presents maker's capacitors, inductors, sockets, insulators, plugs, jacks, knobs, dials, pilot lights and amateur electronic equipment.—E. F. Johnson Co., Waseca, Minn.

Circle **557** on inquiry card.

Transformers. New 2-page Bulletin T354 describes maker's transformers, filter chokes and magnetic amplifiers rated from ½ to 200 KVA.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **558** on inquiry card.

Single-side-band Filter. New 2-page brochure presents description, and diagrams of maker's single-side-band filters.—Burnell & Co., Yonkers 2, N. Y.

Circle **559** on inquiry card.

Magnetic Laminations. New 12-page Catalog ML-101 describes and illustrates maker's magnetic laminations, tape-wound cores, shields and custom-designed magnetic devices.—Magnetics Inc., Butler, Pa.

Circle **560** on inquiry card.

Etched Circuits. New 4-page illustrated Bulletin MD8 10M 3-54 describes and lists applications of maker's etched circuits designed to eliminate hand wiring.—Miller Dial and Name Plate Co., 4400 North Temple City Blvd., El Monte, Calif.

Circle **561** on inquiry card.

Pressurized Plugs. New 2-page brochure describes "Series PE-Z 16" pressurized plugs and aluminum hoods for use with maker's "EZ-Release" series connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C. 1, N. Y.

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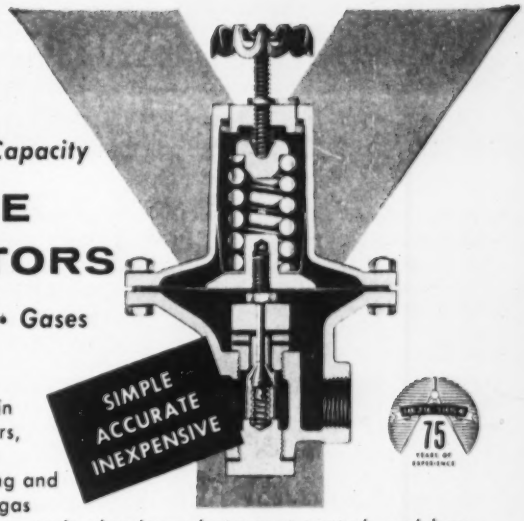

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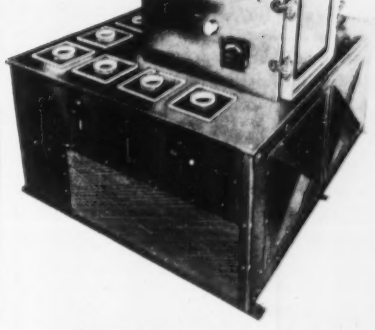

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NEW LITERATURE

Delay Lines. New 8-page brochure describes and illustrates maker's series of delay lines; includes decade-delay lines.—ESC Corp., 578 East 161 St., New York 56, N. Y.

Circle **563** on inquiry card.

Transformers. New 26-page Catalog A describes and illustrates maker's large line of transformers, audio units, hermetically-sealed components, magnetic amplifiers, inductors, toroids, etc.—United Transformer Co., 150 Varick St., New York 13, N. Y.

Circle **564** on inquiry card.

Contact Selector. New slide chart aids selection of solid or composite rivet-type electrical contacts.—Fansteel Metallurgical Corp., North Chicago, Ill.

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Wiring Duct. New 4-page issue of "Watts New" features article on maker's wiring duct.—Machine Tool Electricians, 18500 Schoolcraft, Detroit 23, Mich.

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Power Connectors. New 2-page bulletin describes maker's "Series E-Z 16" precision power connectors with coaxial contacts or bayonet locks.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C. 1, N. Y.

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Test Adapters. New 2-page illustrated bulletin describes maker's test adapters for testing wiring harnesses and electronic equipment utilizing "AN"-type connectors.—Air-O-Tronics, Lancaster, Calif.

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Audio Transformers. New 2-page Bulletin P-9 6-53 lists features, applications and specifications of maker's hermetic "Ouncers", miniature audio transformers.—Thermador Electrical Mfg. Co., 200 South Camfield, Los Angeles 22, Calif.

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Hermetic Seals. New 24-page illustrated brochure presents maker's facilities for producing hermetic seals and assemblies utilizing application of glass-to-metal seals.—Sealtron Corp., Reading Rd., Cincinnati 15, Ohio.

Circle **570** on inquiry card.

Selenium Rectifier. New 4-page bulletin describes and illustrates maker's new selenium rectifier with magnetic amplifier.—Rapid Electric Co., 2881 Middletown Rd., Bronx 61, N. Y.

Circle **571** on inquiry card.

Vibrators. New 66-page Vibrator Manual 554 presents specifications, and illustrations of maker's vibrators with ceramic stack-spacers. Also includes battery eliminators, inverters, etc.—American Television & Radio Co., St. Paul, Minn.

Circle **572** on inquiry card.

TOOLS, FABRICATION

Machine Tools. New 8-page issue of "Hirschmann Highlights" illustrates and describes maker's screw machines, milling machines, lathes, burnishing machines, etc.—Carl

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18	38	58	78	98	118		218	238	258	278	298	318	338	358	378		418	438	458	478	498	518	538	558	578	
19	39	59	79	99	119		219	239	259	279	299	319	339	359	379		419	439	459	479	499	519	539	559	579	
20	40	60	80	100	120		220	240	260	280	300	320	340	360	380		420	440	460	480	500	520	540	560	580	

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NEW LITERATURE

Hirschmann Co., 30 Park Ave., Manhasset, N. Y.

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Taps, Dies, Drills. New folder describes and illustrates maker's taps, dies, screws, drills, punches, gages and tools for instrument manufacturing.—J. I. Morris Co., Southbridge Mass.

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Bevel Protractor. New 2-page bulletin describes and pictures maker's universal bevel protractor with vernier readings in 5 min. of arc.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

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Tools, Dies. New 4-page illustrated brochure presents maker's facilities for producing jigs, fixtures, dies, gages, molds and precision components.—A & M Tool and Die Co., Inc., Foster St., Southbridge, Mass.

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Lettering Instrument. New 18-page illustrated brochure presents description, operation and available type faces of maker's hand-lettering instrument.—Varigraph Co., Inc., Madison 1, Wis.

Circle **577** on inquiry card.

Precision Tools. New 36-page catalog describes and illustrates distributors line of precision tools for repair shops, manufacturers, research departments, etc.—Swartchild & Co., 29 E. Madison St., Chicago 2, Ill.

Circle **578** on inquiry card.

Locating, Drilling. New 4-page illustrated brochure presents description and operation of maker's automatic locating and drilling machine that eliminates manual layout.—Hillyer Instrument Co., Inc., 54 Lafayette St., New York 13, N. Y.

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MATERIALS

Glass Parts. New 8-page brochure presents properties of glass and maker's production processes. Illustrates applications of commercial and industrial glasses.—Lancaster Lens Co., Lancaster, Ohio.

Circle **580** on inquiry card.

Ceramics. New 4-page Chart 544 (supersedes Chart 531) presents latest information on mechanical and electrical properties of "A1SiMag" ceramics.—American Lava Corp., Chattanooga 5, Tenn.

Circle **581** on inquiry card.

Beryllium Copper. New 4-page illustrated Technical Bulletin 24 discusses silver-alloy brazing of maker's beryllium copper.—Beryllium Corp., Reading, Pa.

Circle **582** on inquiry card.

Molded Plastic. New broadside illustrates electronic and electrical applications of maker's "Alkyd" plastic molding compounds.—Barnett Div., Allied Chemical & Dye Corp., 2112 Sylvan Ave., Toledo 6, Ohio.

Circle **583** on inquiry card.

Stainless-steel Wire. New 4-page Bulletin FWM-5-54-5M illustrates and explains applications of maker's stainless-steel wire.—Fort Wayne Metals, Inc., 3211 MacArthur Dr., Fort Wayne, Ind.

Circle **584** on inquiry card.

Anti-friction Compound. New 2-page Bulletin 2-2 describes maker's "Motor Mica" anti-friction compound.—Scientific Lubricants Co., 3469 North Clark St., Chicago 13, Ill.

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INSTRUMENT PARTS

Ball Bearings. New 4-page Supplement 1, Catalog 53 presents description and specifications of maker's shielded, radial, precision instrument ball-bearings.—New Hampshire Ball Bearings, Inc., Peterborough, N. H.

Circle **586** on inquiry card.

Ball Bearings. New 22-page Catalog 541 presents specifications and diagrams of maker's precision ground, instrument and miniature ball bearings.—Microtech Corp., 200 West Colorado, Pasadena, Calif.

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Parts, Assemblies. New illustrated brochure describes maker's plant, facilities and processes for contract manufacturing of parts and assemblies.—Electro-Mechanical Products Co., 32700 Ford Rd., Garden City, Mich.

Circle **588** on inquiry card.

Spring Design. New 8-page bulletin "Precision Spring Design" Part II discusses spring design.—John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.

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O-rings. New 2-page Data Sheet 103 presents description, specifications and dimensions of maker's silicone-rubber O-rings.—Bacon Industries Inc., 192 Pleasant St., Watertown 72, Mass.

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Titanate Ceramics. New 4-page Bulletin 542 presents the physical properties, and applications of maker's two classes of ceramic dielectrics for capacitors.—American Lava Corp. Chattanooga 5, Tenn.

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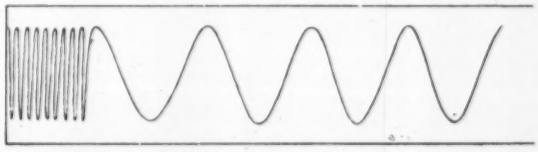
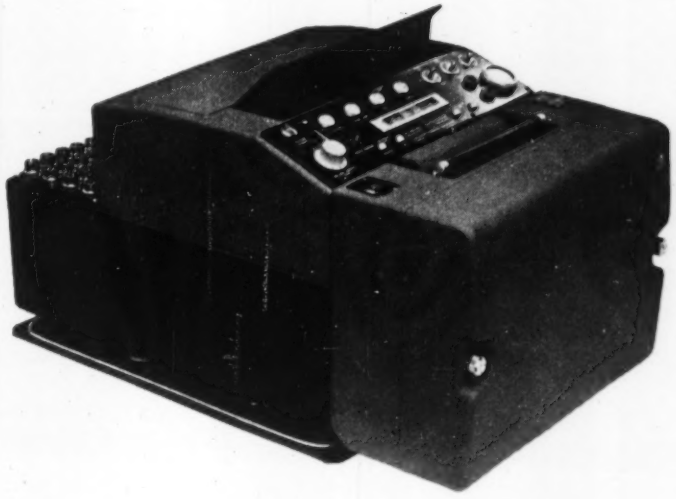
New JUMP-SPEED feature

By actuating a jump-switch, the speed of the record is instantly increased or decreased 10 times without interrupting the test. Complex wave forms in the high frequency range are thus spread over an extended time base, showing both general trends and detailed changes on the same record. The jump-speed feature also facilitates resolution of transient phenomena through expansion of the time axis. Combining the many proved features of CEC's other world famous oscillographs with numerous important improvements, the Type 5-119 Recording Oscillograph represents today's ultimate in high precision dynamic data recording instrumentation. Write for CEC Bulletin 1536-X16.



Increasing or decreasing record speed 10 times spreads complex wave forms over extended time base. This feature permits easier, more accurate interpretation of test records, and clarifies resolution of transient phenomena.



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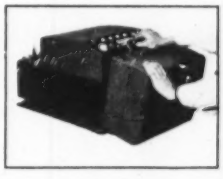

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Convenient grouping of individual galvanometer connectors in recessed panel facilitates use of instrument in limited space.

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